will recognize them as they emerge in the development of my theme. I have added footnotes reluctantly, because their very use is today looked at askance, as Fr. Benard tells us in the *American Ecclesiastical Review* of March, 1945. The layman may disregard them; the student will know how to use them.

I must plead guilty to a certain unevenness of treatment. On reading over the manuscript, I cannot help noticing that some sections are developed at greater length than others, that examples and illustrations are multiplied here and unduly lacking there, that not all statements are backed by incontrovertible proofs, and so on. Some or all the defects mentioned might perhaps be remedied by re-writing or rather re-planning the essay; but then it might never see the light of day. Or it might grow—not exactly like Topsy—but like Linné's *Systema Naturae,* which, we are told, grew from 16 pages in the first edition to 2,400 in the tenth. So I plead guilty and beg the reader's indulgence. I offer three excuses for whatever they are worth: first, I am not a scientist by profession; second, the essay was written with a particular end in view; third, this is really pioneer work, and no one blames Columbus for not having raised New York on his first voyage. It is my earnest hope that, after having received so much from my predecessors, I may contribute something toward the advance of scholastic philosophy.

But to attempt a final answer to all the problems involved in the concept of species, one would need the wisdom of Solomon, who "treated about trees, from the cedar of Lebanon to the hyssop that cometh out of the wall, and discoursed of beasts and fowls and creeping things and fishes" (3 Kings 4:33). It is a task which transcends the powers of any single individual, be he an Aristotle or an Albertus Magnus or a Leonardo da Vinci. Only generations of scholars, willing to construct a brave new world, can hope to accomplish it.

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CHAPTER 1

Introductory

1. The real issue between evolutionists and their opponents turns on the *mutability of species.* Evolutionists claim that plant and animal species are changeable, have in fact changed during the immeasurable periods of geology, and will perhaps continue to change. Their opponents, called fixists, deny this. True, evolutionists differ among themselves as to the extent, the mechanism, the purpose of these changes; nor are their opponents agreed on every point of the controversy. But both friend and foe of evolution grant that the fundamental problem to be solved is this: Are the species of nature mutable or not?

Under these conditions, one would expect both parties to the dispute to lay down a clear-cut and universally acceptable *definition* of "species", or at least to indicate unfailing marks of a true species of nature. Indeed, unless the terms of a problem are fixed at the outset, how can the problem itself be discussed profitably? How will the disputants even know when the problem is solved? A truth as old as the hills—or at least as Cicero, who says in his "Orator" that "unless the disputants agree on their subject, the disputation cannot be carried on as it should, nor end in a definite conclusion".

In the controversy then on evolution which has been raging for nearly a century, the definition of "species" should have received the lion's share of the popular and scientific interest, or at least of the scholars who ranged themselves on either side.

Yet strange to say, this question has hitherto received but scant attention. You may scan book after book and article after article bearing on the subject of evolution, but you

will look in vain for an exact definition of "species". Read the "Origin of Species", the book that made Darwin famous; after perusing nearly 400 pages, you will at last come to the disconcerting admission that the author knows of no sure criterion by which species might be distinguished from mere varieties. Father Th. Harper, S.J. (II p. 517) calls such a procedure somewhat odd. Père Vigouroux (III p. 316-7) is more severe: "C'est là dans son oeuvre une lacune dont on a d'autant plus droit d'être surpris, qu'elle est volontaire et réfléchie. Elle trahit l'embarras de l'auteur. Il en résulte de plus que ses conclusions reposent sur une équivoque". We shall have more to say on this "équivoque" later.

Another example of such slipshod writing is Douglas Dewar's book "Making of Species". He casually refers to the definition of "species" on page 89, while happening to discuss de Vries' "elementary species". Now, if one were to write a book on the making of mousetraps, would we not all expect him to tell us in the first chapter what he means by a mousetrap?

Nor can it be said in extenuation that the term "species" is so clear and unequivocal that only a pedantic grouch could demand an explicit definition. For, as we shall see in the fourth chapter, scarcely another word in the English dictionary is so vague in meaning. Not only that, but everyone admits and many deplore the uncomfortable haziness of the term.

2. But altogether apart from the problem of evolution, the definition and exact determination of natural species is of paramount interest for natural history, that is, for *botany* and *zoology*. For it is the legitimate and supreme aim of every science to construct a system, and the first step toward a truly natural system of plants and animals is the determination of natural species. As long as these are

doubtful, the higher classes and the whole system hangs in the air.

For the same reason, the determination of natural species is of importance for *philosophy*. That part of modern cosmology which takes the whole world for its subject-matter, supposes some knowledge of the natural systems so as to investigate their ultimate causes.

Yet philosophy alone is unable to solve the problem. If it were, I have no doubt that Aristotle or at least the medieval Scholastics would have found the solution, and we could sit back and enjoy the fruit of their labor. Dialectic processes, such as were characteristic of decadent scholasticism and are employed almost exclusively in Adler's book "The Problem of Species", may reveal to us possibilities, but not realities.—Nor is science by itself competent. Science, every science, must take its highest notions and principles from a sound philosophy, in particular from a sound metaphysics. Positivism, with its childish horror of metaphysics, will get the scientist nowhere. No true system of actual plant and animal life is possible without a metaphysical skeleton to give it strength and cohesion.

That the determination of natural species then is a *decided want,* should by now be evident. That it demands an unusual knowledge of both science and philosophy, will become clear as we go on. That few have as yet attempted a solution, I ascribe to extrinsic and intrinsic difficulties, into which we need not enter for the present. But the problem is one which modern scholars, evolutionists or fixists, have to face some time or another.

3. The reader will be helped in understanding my solution of the problem if he keeps in mind three principles which underlie it and with which I carried on my research.

a. *Science and philosophy* must not be divorced from each other. They must not be conceived as watertight compart-

ments without mutual communication. Such a separation would render both sterile. Rather they are meant to be of *mutual assistance*. The material object of any science, mathematics included, is part of the material object of philosophy, which, in scholastic understanding, is knowledge of all things through their last causes. And though the sciences differ from philosophy by their formal object, yet the philosopher expects from the scientist a better knowledge of the factual data and of the laws of nature. The scientist, on his side, is bound by the laws of thought and cognition as well as by the first principles of all things, which only philosophy can give him.

It is unfortunate that the term "species" has, as a matter of fact, one meaning in science and another in philosophy. But the situation is not irremediable. Father Urráburu is perfectly right when he says that he does not see why this should be so: "Nec puto umquam disciplinas hasce (zoology and botany) vere scientifice traditum iri, donec principia et notiones suas fundamentales ex Philosophia mutuentur". The remedy is the harmonious union between natural history and philosophy.

b. I do not beg the reader's pardon for relying, almost exclusively, on *scholastic* principles and notions wherever philosophy enters our problem. After all, the Scholastics are the only philosophers who have a system which is strictly logical, embraces all reality as far as possible, and is thoroughly sound in its fundamentals. Of what other philosophical system can the same be said?

I sometimes play with the idea that if scholastic philosophy had not been banished from our academic halls during the last two or three centuries, the problem of species would have been solved long ago.

c. Instead of indulging in vague generalities, I thought it preferable to give *quotations* pro and con. Such a pro-

cedure acquaints the reader with the pertinent literature, and avoids misrepresenting the opinions of others. It also shows how far other writers on the subject agree or disagree with my views.

Some may object to the numerous quotations from foreign works. But this Essay is not meant exclusively for English-speaking countries. And the sad fact is that English Catholic literature on our subject is wholly inadequate and not always of the highest caliber.

CHAPTER 2

The Domain of Life

We shall not at once attack our specific problem, the determination of species, but shall devote this chapter and the next to a bird's-eye view of the vast domain of life on this earth. Our purpose is to trace its *grand divisions* as well as its essential difference from inorganic nature. Though materialism denies this difference, and though lack of philosophical training or downright prejudice may betray some into denying those divisions, yet common sense admits them both without hesitation.

Still, today it is necessary to offer explicit proofs, because these homely truths have, since the middle of the 18th century, been challenged for various reasons. At that time, de Maillet and Robinet advanced the hypothesis that the lower organisms are merely imperfect attempts of nature at something higher, viz. man, who is the goal of an élan vital present throughout the realm of creation. In his "Histoire naturelle", Buffon wrote: "We see that there is no absolute and essential difference between animals and vegetables, but that nature descends by subtle gradations from what we deem the most perfect animal to one which is less so, and again from this to the vegetable. The fresh-water polypus may perhaps be considered as the lowest animal, and as at the same time the highest plant."[1]

Gradually the *principle of continuity* was evolved, the backbone of the modern theory of evolution. Natura non facit saltus. All things are fundamentally alike; every division merges into the next; no abrupt transitions can be admitted anywhere, no essential differences.[2]

What does common sense say?

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[1]Quoted by L. T. More p. 142-3. Cf. The World's Greatest Books XV p. 19.

[2]Cf. L. T. More p. 213-4.

1. MANKIND

1. Very few will deny that man is in a class by himself and that he constitutes a *natural division* among living creatures. Who indeed would seriously dispute the assertion that all men are essentially the same among themselves as well as essentially different from every other living being on the face of the earth?

We call man an animal. So he is. But do we not all make a clear distinction between man and every other animal we know of? The ourang may resemble us ever so much in anatomical structure and physiological functions; yet who would hesitate for an instant to put him in an entirely different category? We who belong to the white race, may look down (to our shame be it said) on the negro and the Chinaman with a feeling similar to that with which the Brahmin regards the pariah; yet we allow them to open stores in our midst, we trade with them, we converse with them, we close contracts with them; Boston has even colored policemen. As far as manhood is concerned, we put negroes and Chinese on a level with ourselves. Do we act in the same way toward gorillas, ourangs, chimpanzees? Not if we are in our right senses. We lock them up in the zoo or shoot them; we grant no rights to them.

John Locke, the great British philosopher, proposed a difficulty arising from the human foetus, which, in the earlier stages, is indistinguishable from the foetus of an ape or an elephant (*Essay*, Bk. 3, ch. 6 s. 26). The objection is antediluvian. But the fact that the human eye cannot distinguish between these foetuses, is no argument against an essential difference. Locke should have taken another fact into consideration, viz. that no human foetus ever develops into an ape or an elephant, and that the foetus of an ape or an elephant never develops into a human being. Why, if there is no essential difference?

An overzealous evolutionist may rise here and remind that man is really descended from apes or at least has common ancestry with them, and that he is therefore n essentially different from them. But that descent, if tru happened long ago. We speak of man as we ourselves kno him from daily rubbing elbows with him and as authent history describes him. Both sources reveal a wide gap, marked difference between man and every other anim however it may have come about.

2. Man is not only different from all other animals liste in our zoologies; he is *essentially superior* to them.

This statement may not please modern zoologists like G. Miller, of the U. S. Natural Museum, who calls man "a insignificant unit in the class to which he belongs", viz. th of mammals.[3] Also P. E. Raymond, Professor of Paleon tology at Harvard, writes in "Prehistoric Life" (p. 274) "The conception that man is supernaturally set apart fro all other animals finds no support in the study of compar tive anatomy". Perhaps not, but who ever asked comparati anatomy about the "supernatural"? Still, even anatomical and physiologically man is clearly distinct from apes an their allies. While there is a generic resemblance, man y differs from them in a number of characteristics, so much that naturalists place him in a special category, classifyin him, after Linné, as *Homo sapiens.*

But man's preeminence becomes manifest when we con sider that he alone of all animals is endowed with the powe of reflection and free will. Man alone can say I. He alon can freely choose between different goals, knowing himse responsible for his choice. Man alone is his own maste he can voluntarily control his instincts, even the most press ing. No other animal shows any signs of this self-master

[3]1928 Report of the Smithsonian Institution p. 410.

As today, so from the first dawn of history, man exhibits the faculty of cultural and spiritual advance, of employing systematic thought and speech, of setting himself a goal and striving for it, of carrying out designs first blue-printed in his mind. No evidence of a like faculty, not even the crude beginning of it, has ever been discovered in other animals. Man alone is a *rational* animal.[4]

3. Over against the totalitarian state as well as modern sociology with its mob principles, we also hold that each human being is a *person*. Each man is not only born by himself, but also has his supreme end in himself. That end is independent of and above the family, society and state. For each man has an immortal soul, and is bound to make his fundamental elections in accordance with that fact. Neither the state nor society nor the family have an end beyond this life.

4. For the benefit of those who have received no sound philosophical training, we shall do well to answer briefly the question how man's definitions "rational animal" and "Homo sapiens" can apply to *all men*. What their mutual relation is, we shall see below.

a. If man were essentially a rational animal, one might argue, then all men should be guided by right reason in all their doings. Now daily experience clearly negatives this inference. Moreover, what about infants, decrepit old men, insane people? How can they be called rational? And if they are not rational, neither are they persons in the strict sense of the word.

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[4]None perhaps has written so entertainingly on this truth of common sense as Chesterton in the first chapter of the "Everlasting Man". Its philosophical implications were well summarized by M. Thiel, in "Divus Thomas" 1942 p. 3-34. Robert Yerkes, of Yale University, devoted 40 years of laborious experiments to proving the essential psychological difference between man and the primates or anthropoids (gorilla, orangutan, chimpanzee, gibbon).

Now the first part of the difficulty really arises from misunderstanding the nature of definitions. When man is defined as a rational animal, that merely means that all men can, proximately or remotely, act rationally, that they are so constituted and feel the urge to act rationally. But not even Aristotle's logic can prevent a man from making a fool of himself.

Infants, Townsenders and psychopaths are truly human persons. They can possess and inherit, and nobody is allowed to injure them in life or limb; euthanasia, roundly condemned by Pope Pius XI, is held to be a crime by all sensible people. But in infants the various powers are not yet fully developed, while in old folks they sometimes (not always) show the wear and tear of long usage. Nor does insanity make of a man an irrational animal, any more than cutting off a cat's tail will change the cat into a rabbit. Human nature is present in all its essentials; but some obstacle prevents it from fully unfolding itself.

This brings to mind the old accusation that a council of Macon in France once denied that women were persons. But anyone who has ever looked into the case, knows that the dispute then was one of French philology, and had nothing to do with woman's soul or personality.[5] In the face of this hoary charge against the Catholic Church, it is amusing to see Mrs. Eleanor Roosevelt lauded not so long ago (N. Y. *Times* Sunday Mag., Jan. 12, 1941) for stating boldly (under her photo) that women in the future will be regarded as persons.

b. Albert J. Nock, writing in the *Atlantic Monthly* of April 1935, dissents from the scientific definition of man as Homo sapiens. Claiming that the label does not fit the immense majority of humans, this master of paradox holds

[5]Cf. Apologétique p. 1294-5.

with Ralph Adams Cram that only the exceptional man, "the occasional evolutionary product", deserves the title Homo sapiens, and that the mass man is the true missing link.[6]

But it is all a case of taking scientific nomenclature unscientifically. As the term "rational" in the common definition of man must be understood rightly, so the term "sapiens" in the definition accepted by naturalists. It is intended merely to set man off from every other living being, in particular from primates, who have so much in common with man. We shall have more to say about classifying man with the primates, but the zoological definition does not mean, certainly not to zoologists, that none can be called a man unless he is a Newton or an Edison.

2. PLANTS AND ANIMALS

Living beings below man are generally divided into two big classes: plants and animals. Though the division is obvious, yet it is not uncommon today to hear it said that no hard and fast line separates them. Apart from evolutionists, who have an axe to grind, the main arguments are two in number.

1. The first is based on *borderline cases,* such as slime molds, Euglena, Volvox etc., of which W. C. Allee says (Newman's The Nature of the World and Man p. 264): "They combine plant and animal characteristics to such an extent that they are claimed by both botanists and zoologists. There is no distinct line that can be drawn between them and either plants or animals." N. Fasten, Professor and Head of the Department of Zoology, Oregon State College, writes (p. 30): "Often the zoologist classifies them (Euglena and Volvox) as animals, and just as often the bot-

[6] The editor of the *Atlantic Monthly* assures the reader that Nock's thesis is "the expression of his absolute and considered belief".

anist classifies them as plants. Strictly speaking, they are organisms which combine plant and animal characteristics". By others, these and similar creatures are placed in an intermediate class, sometimes called Protista.[7]

The question is, partly at least, one of definition and division. How are plants and animals to be *defined?* What is the *primary difference* between them? Unfortunately, neither scientists nor philosophers are agreed.

Richard Owen declared that a definition of plants excluding all animals, or of animals excluding all plants, is impossible. Modern biology, as a rule, places the essential difference in this: that plants are able to build up living substances out of the non-living (air, water, minerals etc.), while animals feed on "organic" substances. But it is admitted that these definitions leave a remainder on our hands. C. J. Hylander asks himself more than once what is the "primary" difference between plants and animals. He suggests several answers, but finally (p. 16) picks the mode of eating: Plants absorb their food, animals ingest it. Others take the power of locomotion for their principle of division. Thus we read in Thomson's "The Outline of Science" (p. 616): "The true contrast between the two kingdoms is seen in the squirrel romping through the boughs of the impassive beech. The distinction between active animal and sluggish plant is fundamental". Chidester (p. 12) arranges nine "characteristics" of animals and plants in parallel columns; but in a third (middle) column he lists "exceptions" to six of them, where animals show plant characteristics or vice versa. As for the ultimate difference he agrees with Owen: "No one can tell".[8]

Scholastics divide all living creatures below man into sen-

[7]Cf. A. Wolf, Textbook of Logic p. 141; Chidester p. 11.
[8]Cf. S. S. Gager p. 3; A. E. Shipley p. 115, 122; Schwertschlager II p. 71.

tient and merely vegetative. Animals are sentient beings; they can receive in themselves the "forms" of other corporeal beings, though only cognitively (intentionaliter). Plants have vegetative life, but are not sentient.[9]

Truth to tell, the difference between biologists and scholastics is not as wide as might appear at first sight. We shall return to it later. In any case, borderline cases merely attest our ignorance, not an impossible combination of characteristics or indecision on the part of nature.

2. Popular writers harp on the *oneness of life* as another reason for refusing to separate plants and animals into distinct classes. Thus D. C. Peattie writes in the *Reader's Digest* (March 1940): "The more one knows about the two kingdoms, animate and vegetating, the less he perceives any boundary between them, until he finally comes to deny the existence of any boundary". The same line of argument is taken by J. C. Needham, Professor of Entomology, Cornell University, in his "The Animal World" (p. 38-40).

This is merely another phrasing of the principle of continuity. But where is the body of outstanding scientists that have placed this principle on a firm basis—as should be done with first principles? To the philosopher it looks very much like a mischievous assumption. No doubt, all men can be made equal by overlooking all inequalities, and men and animals are alike if we forget their differences, and all beings are the same if all diversity is ruled out of court. But then what about reality which science and philosophy are supposed to explain? There would be continuity if there were no breaks, and we might proclaim essential continuity all around if reality did not manifest diversity.

[9]Cf. Urráburu, Psych. I p. 725-6, 950; T. Pesch, Welträtsel I p. 497; J. Fröbes, Psych. spec. I p. 20. The author of the article "Die Pflanze" in "Der grosse Herder" rejects the scholastic distinction as wholly untenable; but, like Robinet, he confuses sensitivity with irritability and tropism.

3. A like confusion of ideas arises when mere *multiplication of cells* is taken as the one characteristic of life. No doubt, all metazoa originate from one cell, which in due time multiplies into the billions of cells that constitute the average plant or animal. In so far we may speak of the oneness of life or of the principle of continuity throughout the domain of life. But that is only half the story. Mere multiplication without differentiation is cancer and means death. Reality reveals not only multiplication of cells, but also differentiation. Organic life means some homogeneity of integral parts, but also heterogeneity of a definite kind. Chidester rightly insists on this point of view (p. 13) : "As adults Metazoa are made up of cells arranged in unlike groups. Definitely specialized for particular functions, we find the cells dependent on one another, and manifesting a pronounced 'division of labor' ". No biologist would subscribe today to Lorenz Oken's thesis that all parts of higher animals are aggregates of "infusoria".

3. LIVING AND NON-LIVING

What is life? What is the difference between living and lifeless? Is there any real difference? Or is biology merely a branch of chemistry and physics?

1. Biology is the *science of life*. This self-evident definition obliges biologists to ask themselves: What is life? Lacking the philosophical outlook, most of them answer it without being aware that there is life and life. They at once restrict life to the lowest kind, vegetative life. If they are evolutionists, they may add that sense life developed from it—naturally, but casually—and that intellectual life is nothing more than glorified sense life. Many profess ignorance and are content to indicate some "characteristics" of life.[10]

[10]Cf. McDougall p. 7-9. Monaco (p. 57-59) discusses the definitions

Being philosophers by profession, Scholastics take a wider view of things. They hold, of course, with all sensible people, that there are three kinds of life: vegetative, sensitive and intellectual. But they also insist that life may exist independently of matter. They hold that God lives, though absolutely independent of matter, that the angels live, that the human soul can perform some vital functions without direct aid from matter.

This wider view leads them to three conclusions: a) They say that biology to be exact should be defined as the science of *organic* life; for that is the only kind of life of which modern biology treats. b) They deny that everything that lives must *die* sooner or later; for that is true only of organic life; even the human soul, though dependent on an organism to some extent, is immortal. c) To Scholastics, life in general (vita ut sic, as they say) is a sort of *transcendental term*, which can be predicated of every kind of life: divine and human, intellectual and spiritual, sensitive and vegetative. It is not a generic term properly so called, because the various kinds of life add nothing that is not also life.[11]

Scholastics then define life as "immanence" or *"the power of immanent action"*, that is, action beginning and ending in the same subject. Sometimes they say that life is "the natural power of moving oneself"; but this definition is to be taken in the same wide sense as the preceding, and must by no means be limited to locomotion or efficient causality. "Non-life" is the natural lack of this power; lifeless things must be set in motion; they cannot move themselves.

Moreover, Scholastics distinguish three *essential grades* of

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of earlier biologists: E. Stahl, Bichat, Richerand, Lamarck, Cuvier, Spencer.

[11]This is also the meaning of "Life" in the heading of this chapter, though it is here restricted to life on this earth.

life: vegetative, sentient, intellectual. The first is the lowest, the most imperfect as far as immanence of action is concerned. Sentient life is essentially higher, because immanence is more perfect; and for the same reason intellectual life is essentially higher than either. Even intellectual life is not the same in all who possess it; in man it is of one kind, in angels of another; in God alone it is the most perfect, because His intellect and will do not depend at all on anything outside of Himself.

2. From this exposition one may conclude how Scholastics judge the *"characteristics of life"* generally enumerated in biology and sometimes offered as a substitute for a definition of life? Their premises oblige them to say that these pertain only to one kind of life, and that the lowest. Metabolism, growth, reproduction, irritability are not characteristics of sense life or intellectual life; they are present in animals and men only because of their vegetative life; they are absent altogether from those beings which lead a life independent of matter.

Scholastics make a like proviso for the *"physical basis of life"*, a pet modern phrase introduced by Max Schultze and popularized by Thomas Huxley. Protoplasm, which is meant by it, is the basis of vegetative life, but not of sentient or intellectual life, except in so far as these depend on the first.

3. But there is evident today a tendency to efface the unmistakable gap that separates the living from the non-living, as witness the "Syllabus for the Introductory General Course in the Biological Sciences" (Chicago 1937) quoted by Adler (p. 268): "Although there is no difficulty in identifying a mammal or a tree as a living organism in contradiction to the ground on which they are seen, the distinction becomes less clear as one approaches the line of division of the simplest form of life from the more complicated non-living system. . . . Truly the concept of life breaks

down at this level, and there is every reason to believe that all stages of transition from linseed oil which "remembers" to micrococci exist. . . . A man and a marigold do fundamentally the same things. The various organ systems which make the two so entirely different, are merely the answers to the same problem". The Chicago Syllabus does not stand alone, but expresses the common doctrine of non-Catholic American textbooks on biology, physiology etc.[12]

Now it is scarcely necessary to prove that not all things in this world are alive. Though life, vegetative life, is based on chemical structure, it is precisely more, as the "characteristics of life" indicate, and as a sound philosophy proves convincingly. Besides, the chemical structure of organisms is, as a matter of fact, constantly different from that of lifeless things, be they ever so complex. It is also a fact that no chemist has yet produced one living cell, be it ever so simple.[13]

Finally, man stands head and shoulders above the rest of visible creation. Only a priori prejudice or a total disregard of fundamental notions could make one forget the insuperable barrier between man and every other being, living or non-living. To say then, as does the Chicago Syllabus, that "man and the marigold do fundamentally the same things", implying, of course, that there is no essential difference between them, is plain silly.

CONCLUSIONS

The foregoing considerations entitle us to draw two important corollaries.

1. The first is the acceptability of the *common sense division* of all things on this earth: a) the unique nature and essential superiority of man; b) the division of all visible

[12]Cf. J. A. Hardon, in *The Catholic World* 1946 p. 527-531.
[13]Cf. Dwight p. 118-147; Chidester p. 3-4, 420.

creation into living and non-living; c) the division of all earthly life into three essentially different classes: man, animals, plants. The truth of this division is too firmly rooted in every-day experience to be shaken by imaginary doubts or fanciful arguments on the part of some scientists or would-be philosophers.

But what about the scholastic axiom: Natura non facit saltus? Does it not imply that the Scholastics recognized no sharp divisions in nature? Does it not favor the oneness of life and the principle of continuity which modern writers extol so much?

It might, if taken out of its context, viz. the framework of scholastic philosophy. But within that framework, it merely referred to the gradual ascent of being from the lowest creature to the Creator. Nature in its grand outlines is differentiated into lower and higher, but so that the intermediate classes *combine* the lower and the higher. The lowest entity to the Scholastics is prime matter; only one step removed from nothingness, it might almost be said to combine in itself being and not-being. The individuals of the inorganic world are, however, not pure matter (as modern science supposes), but embody a higher principle, a substantial form, which gives them being and existence. In plants, this form is vital (soul); in animals it is vital and sentient; in man it is spiritual. Angels finally are pure spirits like God, yet not eternal like God.

It was thus that the Scholastics conceived the unity of all beings and the oneness of life. But who does not see how much this conception differs from that of modern writers who slur over all essential distinctions?[14]

Truth to tell, *Leibnitz* already changed the meaning of the scholastic axiom or rather misapplied it. He appealed

[14]Cf. Lahr II p. 428.

to it to prove the existence of *Zoophyta,* beings between plants and animals; otherwise, he argued, the continuity of nature would be broken. But whatever one may think of Zoophyta, their existence can certainly not be deduced from the scholastic axiom. For if such a proof were at all valid, one could argue that there must be beings between plants and Zoophyta as well as between Zoophyta and animals—and so ad infinitum. In other words, the argument would lead to an infinite number of actually existing classes. Now this is impossible. Therefore the argument itself is invalid; it sins by applying the a priori method where the a posteriori method is the only legitimate one.[15]

2. Another important corollary is that these divisions are *natural.* They are not man-made or artificial. They exist spontaneously. They existed long before man came, as paleontology testifies, and will conceivably continue to exist after man has disappeared. And being natural, they are *constant.* They are kept up through the workings of the laws of nature, and as the laws of physics and chemistry can be proved to have remained unaltered as long as recorded history extends, so also the laws that govern the continuance of these divisions. Nature does not change her moods or ideas over night. As we have no knowledge that the law of gravity has ever changed, so the burden of proof is on him who would assert that biological laws have undergone a change in the past or will be other in the future.

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[15]Modern zoologists also use the term Zoophyta and zoophytes but not in Leibnitz' sense.

CHAPTER 3

Origin of Life

Though not necessary for the specific subject of thi essay, a brief discussion of the origin of life on this plane is a natural complement of the preceding chapter.

1. Anyone who believes in the divine inspiration of th Bible, must confess that *God stands at the beginning of lif* on this globe. This truth is clearly contained in the firs chapter of Genesis. For though that chapter was writte in a popular style and conformably to the mentality of th Israelites of the time, yet its author certainly intended t teach God's direct intervention to begin the process of lif on this earth.

Almost all Catholic scholars agree on this interpretation One of the very few exceptions is Canon Dorlodot, wh attempted to prove two propositions: first, that Genesis i not opposed to "absolute evolution", that is, "the theory which excludes all special intervention on the part of God even in the origin of life" (p. 65); second, that "the teaching of the Fathers is very favorable to the theory of absolute natural evolution" (p. 66). Whence he concludes that Scripture does not forbid us to go beyond Darwin and that the teaching of the Fathers positively encourages us to do so.[1]

But the common interpretation of Catholic exegetes is that God created life by an act distinct from that by which He first created the inorganic world.[2] Dorlodot's second proposition contains a flagrant misuse of the technical term "the teaching of the Fathers", which has a quite definite meaning in Catholic theology. Furthermore, it is certain that

[1]Cf. Agar p. 63-6, 89.
[2]Cf. Ceuppens p. 18-40.

neither St. Gregory of Nyssa nor St. Augustine, Dorlodot's only authorities, ever taught anything of the kind.[3]

Dorlodot's thesis was nevertheless reaffirmed in Apologétique (p. 1220). There it is argued that St. Thomas, who admitted spontaneous generation, saw no contradiction between his understanding of Genesis and a similar beginning of life without the direct intervention of God.

This is a misinterpretation of St. Thomas. In his Summa theol. I qu. 73 a. 1 he explains and defends Genesis 2, 2, where it is said that God completed his work on the seventh day. His third objection is to the effect that since the seventh day of creation many new things have appeared: new individuals, new species of animals, new human souls etc. His general answer is that all these things preexisted in some way (aliqualiter) in the works of the six days of creation. In particular, for the cases of spontaneous generation, he postulated a special power in the stars and the elements which they had received from the beginning. We shall return to this point in chapter 12.[4]

2. But the appeal to Genesis is really not necessary. Reason can see no other alternative for the beginning of life on this globe except divine intervention. The *principle of causality*[5] demands an adequate cause for whatever begins to exist, and there is no adequate cause for the beginning of life except God's omnipotence. How indeed could transient activity pass of itself into immanence? For that is the difference between non-living and living, as the Scholastics always taught. Non-living beings can only act when moved from

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[3]Cf. Boyer p. 105-112; van Hove p. 94-6; Marcozzi, in Civilità Cattolica, 20 Dec. 1941 p. 421-2.

[4]Cf. Maquart p. 516-8.

[5]This principle is here taken in its old scholastic meaning, in which it is an analytical proposition and absolutely certain. Modern scientists rather take it to refer to the uniformity of nature.

the outside and can only act on other things; living being are the beginning and terminus of their activity.

Therefore, to bring life out of non-life, to change coars matter into a living organism for the first time, calls fo a preternatural cause.[6]

We have here an interesting case of that positive aid whic revelation gives to reason. None of the ancient philosopher not even Aristotle, arrived at this explanation of the origi of life. They all assumed a sort of spontaneous transitio from the inorganic to the organic. The Stoics, profounde than the rest, postulated generative forces as partial cause But the mystery remained. It was the Fathers of the Churc and the Scholastics who, taking for granted the truth o the first chapter of Genesis, formulated the philosophica proofs for the necessity of a special divine intervention t start the process of life in dead matter.

3. Modern biology has confirmed this philosophical con clusion by rejecting the theory of spontaneous generatior The spontaneous origin of life out of non-life, of whic the ancients thought they had ocular evidence, is now see to have been a myth. In the course of nature, life arise only from life, and Harvey's axiom *"omne vivum ex vivo* is now accepted universally. When Jacques Loeb artificiall fertilized the eggs of the sea-urchin and got results, the re porters wired their papers that he had produced life. Loe was disgusted. He knew that if there had been no life i the eggs, if they had first been boiled, his experiments woul have been without result.[7]

4. Yet under the sway of modern rationalism (or rathe irrationalism), this explanation of the origin of life is agai

[6]Cf. Frank p. 84-108; O'Toole p. 131-188; Anable p. 77-83; Schmi ch. 5; Giesen-Malumphy ch 11.

[7]But Loeb's conception of life was wholly mechanistic; living or ganisms were mere machines to him. Cf. Brennan, Hist. of Psych p. 180.

controverted or flatly denied. In his "Origin of Species" (1859), Darwin postulated creation for a few primitive types. But his more logical friends reminded him of the old saw "principiis obsta"; if a preternatural cause is once granted to have been operative, they reasoned, then it cannot be excluded from similar cases. So Darwin changed his mind in the "Descent of Man" (1871), without, however, coming to a settled conviction. Metaphysical arguments gave him a headache.

Modern naturalists are more resolute. N. Taylor, for instance, is quite sure that God had nothing to do with the beginning of life. "It is not necessary", he says (p. 300-1), "to ascribe the origin of life to providential inspiration nor to the meddling of strange and outlandish deities, as all savage tribes did and some more civilized people still do". And a little later on he repeats (p. 338): "Our modern plant life is derived from preexisting life, and not from providential or special creation".

Taylor's contention might be worth looking into if life, organic life, always existed on earth. But modern geology knows of an *azoic* or *archaic era,* when no life existed on this earth, not even algae, the darling babies of evolution. What happened between that and the paleozoic era? True it is that paleontologists speak of an archeozoic and a proterozoic era preceding the Cambrian period. But E. W. Berry simply ignores them in his Paleontology, because "their rocks have not as yet furnished anything but vague and circumstantial traces of organisms" (p. 2). Be that as it may, whether the first era of organic life be called paleozoic or archeozoic or proterozoic, does not affect our question at all. There once was *transition from non-life to life,* and that calls for an adequate cause.

N. Fasten gets rid of God by the familiar trick of beclouding the issue. He mentions four theories to explain the

origin of life (p. 45-6). But the first, the "Creation Theory", is saddled with so many details, essential according to him, that it contradicts the assured findings of paleontology and can then be rejected out of hand. R. W. Hegner (College Zoology p. 22) thinks that "the doctrine of Special Creation . . . is sufficiently refuted by the facts of organic evolution to require no discussion", and he deplores the fact that Linné believed in special creation (ib. p. 25). L. T. More, Professor of Physics in the University of Cincinnati states his own creed thus: "We accept it (a general law of evolution) as we accept the law of conservation of matter not because it can be proved to be true from experience, but because without it natural law is not intelligible. The only alternative is the doctrine of special creation which may be true but is irrational" (p. 21-22).

5. And what will take God's place? What is the *alternative to divine intervention?* It used to be spontaneous generation, but that has gone out of fashion since Pasteur proved it to have been an illusion.[8] Professor Fasten makes his own the "physicochemical evolution theory" (p. 50): "Living matter", he says, "slowly arose from non-living matter just as soon as conditions upon our planet became ripe for such a thing to occur". As simple as that. He repeats it again a little later (p. 52): "The majority of scientists are of the firm conviction that many, many years ago living matter arose from the materials of the non-living environment, when conditions upon the earth reached that stage of complexity where such an event became possible". A philosopher would say that the Professor is selling us words for ideas and adequate causes.

Forced to find a substitute for creation at all cost, others speak of "the great life experiment", which resulted in the

[8]Cf. Monaco p. 143-7, 155-163.

first tiny organism or dab of protoplasm. Thus P. E. Raymond writes in his "Prehistoric Life": "Nothing is really known about the origin of life, but it seems probable that its inception was the result of a huge chemical experiment, during which conditions were such as had never previously obtained on this planet and will never be repeated". Which has all the earmarks of a hypothesis ad hoc. But one may ask the learned Professor: Who performed that huge experiment? Who brought together the materials necessary for it? Who devised the formula for it? And finally, why does life persist though the conditions for its origin have vanished irretrievably?

6. N. Taylor is honest enough to confess that he stands before a *perpetual riddle*: "The actual origin of life is still as much of a riddle as it was when the ancient philosophers began to speculate about it years before the Christian era". Ch. R. Knight, too, writing in the *National Geographic Magazine* of February 1942 (p. 141) admits that the profound conundrum of the existence of life on our globe is as much a mystery as ever. C. S. Cager says in "The Great Design" (p. 163): "As to the steps by which protoplasm and cells evolved from non-living matter we are almost wholly ignorant". Hegner (College Zoology p. 22) also comes to the conclusion that "we do not know when or how life originated and probably will not know for many generations to come". M. S. MacDougall (Biology. The Science of Life p. 10, 13) has no better answer.

And so it is either God or *agnosticism* of a kind. Having forgotten or abandoned the revelation once granted to mankind, modern scholars prefer ignorance to truth.

7. We have taken "life" so far as a more or less transcendental term. But life in the concrete are the three great classes established in the last chapter: plants, animals, and man. Since they are separated from one another by un-

bridged gaps, the problem of the origin of life is really thi How did each of these three divisions originate?

Let us now consider plants and animals.

Again we claim that *God stands at the beginning* of eac of the two kingdoms. And an appeal to the first chapter c Genesis would again be justified. For there we read: "An God said: Let the earth bring forth the green herb, an such as may seed, and the fruit tree yielding fruit after i kind, which may have seed in itself upon the earth. . . Let the waters bring forth the swarming creatures havin life, and the fowl that may fly over the earth under tl firmament of heaven. . . . Let the earth bring forth tl living creature in its kind, cattle and creeping things, an beasts of the earth, according to their kinds." While, as h been said, that chapter was not meant as a scientific expc sition of creation, yet its author, divinely inspired, certainl intended to assert that plants and animals existing at h time, as far as they could not naturally originate from or another, were originally called into being by the all-powerf word of the Creator.[9]

Yet again, we could really dispense with an appeal t Scripture. Reason has enough convincing arguments of i own. The *principle of causality* demands a preternatur cause for the beginning of each of the two kingdoms. Eac was something unprecedented, something absolutely nev something on a definitely higher plane, something that coul be initiated only by God's power. There may be evolutio within the two kingdoms, but to speak of spontaneous evc lution from non-life to plants or from plants to animal is just dribble.

But we shall have more to say on this in later chapters.

8. Much more than for plants and animals, we insist th

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[9]Cf. Dict. de la Bible, Suppl. s.v. Génèse col. 602.

God stands at the beginning of the human race. For this we confidently appeal to Genesis, where the origin of the first man and the first woman is narrated. In the first chapter we read: "And God created man to His own image; to the image of God He created him; male and female He created them" (v. 27). The second chapter goes more into detail: "And the Lord God formed man of the slime of the earth, and breathed into his face the breath of life, and man became a living soul" (v. 7). "Then the Lord God cast a deep sleep upon Adam, and when he was fast asleep, He took one of his ribs and filled up flesh for it. And the Lord God built the rib which He took from Adam, into a woman, and brought her to Adam" (v. 21-22).

With the Biblical Commission, Catholic exegetes concede that some phrases in this account are to be taken metaphorically.[10] But while granting this much to modern criticism, they are unanimous in maintaining that it was the intention of the sacred writer to teach the Israelites that man's first origin was due to God's special intervention.

But a distinction must be made.

For man, as we know him, consists of two substantial parts, one of which is the *human soul,* and it is certain that the human soul is *spiritual,* intrinsically independent of the matter with which it is united in this life. Now something spiritual cannot evolve from something material, such as is the animal soul. How indeed could the animal soul, which is intrinsically dependent on matter in all its actions, make itself independent in any of them? Such a process would be nothing less than raising oneself by the bootstraps. Creation in the strict sense of the word is the only way by which the human soul can come into existence, and creation belongs to God alone.[11]

[10]Cf. Bea, in Biblica 1944 p. 75-6; Dict. de la Bible, Suppl. s.v. Adam et la Bible col. 91.

[11]Cf. O'Toole p. 189-267.

It was on this point that Catholics and many Protesta parted company with the novel theory of evolution, especi ly as propounded by Spencer, Huxley and Haeckel. Not o that, but they went over to the attack, showing the absurd of attributing to evolution the origin of the human so Some evolutionists have tried to meet these attacks, but wi out success. Conklin, professor of biology in Princet University, an out-and-out evolutionist, instead of produci arguments, indulged in vicious invectives, damning the tacks as the most ignorant, frenzied and intolerant that ha ever been made against the theory of evolution. But mu slinging is not scientific evidence.

Things are less clear when we come to the human bo man's other substantial part. But we defer discussion of origin to the last chapter.

CHAPTER 4

Modern Skepticism

Chapters 2 and 3 were preliminary. We now descend to those classes of plants and animals which are commonly designated as "species"; for it is with them that this essay deals primarily. The question is how to *define* species. Rousseau once said that definitions would be a good thing if we did not have to use words to make them. But constituted as we are, it would be vain to attempt to get along without words, as vain as attempting to walk without legs.

1. When discussing the concept of time, St. Augustine makes the shrewd remark: "If you don't ask me to define time, I know what it is; if you ask me, I don't know" (Quid familiarius aut notius in loquendo memoramus quam tempus? Et intelligimus utique cum id loquimur; intelligimus etiam cum, alio loquente, id audimus. Quid est ergo tempus? Si nemo ex me quaerat, scio; si quaerenti explicare velim, nescio. Confessiones xi 15).

Something similar is true about the concept of "species" as applied to plants and animals. Mere common sense indeed is not of much assistance here. There is nothing very definite about the vulgar concept of species, I mean the concept had by the farmer, the hunter, the fisherman, the horticulturist, the suburbanite, the keeper of the municipal zoo. A species to them is roughly a group of plants or animals which are closely alike and differ from similar groups by some more or less constant characteristics. Clearly, such a concept will not stand up under fire, since it does not sufficiently differentiate species from genera or varieties.

But naturalists by profession are equally at sea whenever the concept of species is up for discussion. They will glibly name species after species until brought up short by the

simple question: What then is a species? What do you me by species? Which are the true species of nature?

This assertion may sound somewhat derogatory to na ralists, but any book bearing on the subject will substar ate it. Let me cite a few instances taken at random fron vast literature.

R. S. Lull, Professor of Vertebrate Paleontology at Y and famous collector of dinosaurs, writes: "While biologi have not yet succeeded in arriving at unanimity of opin as to just what constitutes a species, the general concept of a kind of animal or plant to which a definite name l been given, such as red fox, timber wolf, coyote or jack just about expresses the idea" (Organic Evolution p. 5(Let the reader note the vagueness of expressions like "j about", "general conception", "a kind of" on a point wh is of capital importance to the author's main thesis. R. Conn, the well-known writer on biology, is, if possible, ev hazier: "To give a definition of just what is meant by s cies, is impossible, since no one knows just what is mea and the word perhaps does not always have the same mea ing" (Biology p. 370). Hardly more accurate than the v gar concept is C. J. Hylander's definition of plant speci "a group of individuals so closely related that they do r apparently differ from each other in any important wa (The World of Plant Life p. 8). H. H. Newman, Prof sor of Zoology in the University of Chicago, frankly a knowledges that "there is nothing really definite about term 'species'" (The Gist of Evolution p. 34). Also Dewar, in the book referred to, says: "We may take t opportunity of remarking that the definition of species one on which naturalists seem to be unable to agree. . Each class of systematists has its own particular criter of what constitutes a species". E. Mayr (p. 115) thinks no exaggeration to say "that there are probably as many s

cies concepts as there are thinking systematists and students of speciation", though he then goes on to classify them all into 4 or 5 groups.

As a last witness to the prevailing uncertainty, let me cite the latest (3rd) edition of the "Vocabulaire technique et critique de la Philosophie", published by Lalande. Though the writers aim at scientifically accurate definitions, they confess their inability to give a rigorous definition of species, at least as far as the vegetable kingdom goes. They judge that the obstacles encountered in the formulation of a good definition have discredited the idea that species are something fixed and differ radically among themselves.

2. Science is nothing if not exact. Modern science demands exactness in its measurements. It should also demand exactness for definitions and divisions; without them the very foundations are lacking, and each scientist may, even while employing the terminology common to all, construct a synthesis of his own.

In our particular subject, the lack of precise definitions has led to a lamentable *confusion of terms and concepts.* I refer to terms and concepts such as species, genera, races, varieties, families and so on. They are either not defined at all, or they are given such loose definitions as to be useless for all practical purposes. R. Hertwig, more than a generation ago, arrived at the conclusion that "sharp distinctions between species and varieties did not exist; that species were varieties which had become constant, and that varieties were incipient species". More recently, E. W. Castle, of Harvard, substantially voiced the same idea: "At present, he says, we use the terms 'species' and 'variety' in a relative sense only. The differences which exist between species are supposed to be either more numerous or greater than those which exist between varieties. The terms, to the majority of biologists, imply nothing more than this" (p. 83). L. H. Bailey

likewise says: "Where the variety ends and the specie begins it may be utterly impossible to determine; so we mar off at a certain point and say, arbitrarily, that this much i variety and that much is species. . . . The idea of variet or species rests upon difference, but just how much differ ence shall constitute one grade or another is a matter of in dividual opinion" (Plant-Breeding p. 33). N. Taylor con cludes: "Species and varieties are concepts of convenience nay of absolute necessity, in talking and writing abou plants, but hardly expressions of exact truth" (Botan p. 330).

3. But while most biologists deplore this uncertainty J. Graham Kerr, F.R.S. and Regius Professor in the Uni versity of Glasgow, gives it his blessing. Pointing ou (Evolution p. 6) that the German for "species" is "Art" which may also vaguely mean "kind", he continues: "Thi is of advantage, for it helps to guard against the concep tion of species assuming in one's mind too rigid and precis a character". But since when does science thrive on hazines of thought and *looseness of speech?*

The same Professor applauds the *relativism* underlying modern concepts. "There is no correlation", he says, "be tween the amplitude of the conception 'species' as used in one group and as used in another. A classifier of dipterou flies, or of oligochaete worms, or of mammals, or of corals becomes able to formulate in his mind a more or less precise idea of what he means by 'species', but this idea is of littl value outside the boundaries of his group. It is one of the very few evil effects of the publication of the Origin o Species that it has tended, by its title to foster the idea o species being equivalent throughout the realm of living na ture".

4. The upshot of this intellectual confusion is the sugges tion of *dropping* the term "species" altogether from scientific

nomenclature. It comes from no less an authority than Sir E. Ray Lankester.[1] Indeed, one may ask: Why should science burden itself with a term of which no scientist seems to know the meaning, or whose meaning is arbitrarily determined by each systematist?

But to the layman the procedure here recommended looks very much like playing possum. The problem of species will remain alive even though we drop the term "species" or substitute for it "circulus", as suggested by J. W. Gregory, of Glasgow University.[2]

5. Still, one may venture the query: If St. Augustine's remark about the definition of time may be and has been called ingenious, why not say the same of biologists? They know very well what they mean by species if not asked to define; if challenged, they hesitate and stammer like St. Augustine. Or are there two kinds of weight for appraising thinkers?

No. But there is a vast difference between the two concepts. "Time" is a so-called primitive concept, directly abstracted from experience. Such concepts are scarcely amenable to definition except in a wider sense; definitions merely clarify them, marking them off from similar or opposite concepts. In our subject-matter, other such concepts, are "essence", "change", "difference", "division", "purpose" etc. as we shall see. But the biological concept of species is of a different nature; it is a *scientific* (and, as we shall see, a philosophical) concept and must be carefully defined to be of any use. We might compare it to "standard time" or "mean solar time", concepts which can be defined exactly and satisfactorily, whether we accept Aristotle's definition of time or not.

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[1]Encycl. Brit. s.v. Species; J. Y. Simpson, Landmarks in the Struggle between Science and Religion p. 177-8.
[2]Cf. *Thought* 1928 p. 515.

CHAPTER 5

History of the Concept of Species

If we believe the naturalists quoted in the last chapte the outlook for botany and zoology is discouraging, at lea as far as systematics is concerned. If, as some say, nature species are merely distinguished by different names as tl houses in a city block are by numbers, then natural histo as a science is bankrupt; it has become a dictionary of name Worse than this. If each systematist is free to draw up h own list of species, then there will be as many dictionari as there are systematists.

Still, things are not so hopeless. And as a first step o of the depression, let us go back in history. The ter "species" was not always as vague as it is today; and think the reader will better realize the problems involve in the term as well as the possibility of their solution i we begin with its original meaning.

THE SCHOLASTIC CONCEPT

1. To Aristotle and the medieval Scholastics, the scien tists of yesteryear, the term "species" was familiar enoug It had then several meanings, but three of them, closely al lied, bear on our problem.

First, species might be taken in the concrete as a *grou of beings having the same complete essence*. This is still th meaning given first in our dictionaries, and the term is s used when we speak of the "human species". Still, it neve was the primary meaning intended either by Aristotle or th Scholastics.

Secondly, species might be taken in the abstract as th *complete essence* common to a group of beings. Thus "ra tional animal" expresses the complete essence of man and i

common to all human individuals. As this fulfils the definition of the universal "one in many", it was generally understood as *the* meaning of species. Even John St. Mill (System of Logic, Bk. 1 ch. 7 n. 5) knew that it was a scholastic axiom that the species contained the "whole essence" of a thing.

However, taken thus, the term may have an ontological and a logical sense. In the *ontological* sense, the complete essence is not conceived as common to a group, that is, its relation to the group is not included in the concept. In the *logical* sense, the complete essence is conceived as common, and its relation to the group is distinctly contained in the concept.

Truth to tell, Aristotle had not distinguished accurately between the ontological and the logical use of such terms as essence, concept, substance, subject etc., all of them related in some way to species. This distinction was the work of the medieval Scholastics. After them, Suarez introduced new names, calling the species in its ontological sense the direct universal, in its logical sense the reflex universal.[1]

Thirdly, species might be taken precisely as that peculiar *relation* which exists between a complete essence (in the abstract, of course) and the individuals which have it in common; as e.g. the relation existing between "rational animal" and all human beings.

The Scholastic definition has one great advantage. It marks species clearly off from the two cognates with which it is so often confounded today: varieties and genera. Varieties are infra-species; having the same complete essence,

[1]Nevertheless the distinction is not yet fully grasped, as witness the controversy which ensued on the appearance of Adler's Problem of Species. Cf. J. Muller-Thym, in *The Modern Schoolman*, Nov. 1940; J. Maritain, in *The Thomist* 1941 p. 45-53; G. Smith, in *Thought* 1940 p. 710-2; Adler, in *Thought* 1941 p. 200-4. We shall have more to say on this division later (infra p. 117).

they belong to the same species; differences between them were called "individual" by the Scholastics. Genera, on the other hand, are supra-species; they constitute higher and wider classes than the species.

THE BIOLOGICAL CONCEPT

The Scholastics applied their concept of species to everything indeed, but not so much to plants and animals, which interested them less. That was done by the naturalists of the 17th and 18th centuries. These, being still imbued with the spirit of scholasticism, felt the need of accurately defining biological species before attaching the label to its counterpart in nature. The use of ill-defined terms was then taboo as much as exact definitions are today. There was only this difference from scholastic usage that the first, the concrete meaning of species, was employed, though this practice did not imply a denial of the other two allied meanings.

1. John Ray, the English botanist, was the first to introduce into natural history a precise conception of species, applying the term to individuals derived from similar parents and themselves capable of reproducing their kind. G. L. Buffon, the French naturalist, defined species as "une succession constante d'individus semblables et qui se reproduisent". G. Cuvier's definition is about the same: "A species is a collection of individuals born from one another or from common parents, and of all those which resemble them as much as they resemble one another". Jean Quatrefages described the species as "the totality of individuals, more or less alike, which are descended or may be regarded as being descended from a primitive couple by an uninterrupted and natural succession of families".

Adding a third element, mutual fertility and sterility, Karl A. von Zittel wrote in his Textbook of Paleontology (p. 10-11): "According to the Linné-Cuvier doctrine, a species is

composed of individuals which are directly descended from one another or from common ancestors, and which resemble their progenitors as much as they resemble each other. Members of one and the same species interbreed, but individuals belonging to different species do not, or when they do, produce infertile or imperfectly fertile offspring". According to the same authority, this definition of biological species was current in the schools in the latter part of the 19th century and so may be called classical. It is at least partially contained in the definitions of two American naturalists. C. S. Gager (The Plant World p. 125) defines the plant species as "a group of plants essentially alike in their fundamental structural characters, and which, through a series of generations, normally produce offspring having the same fundamental characters as themselves". Of animal species R. Hegner says (Parade of the Animal Kingdom p. 1): "The simplest definition is: a species consists of a group of closely similar individuals which do not mate with individuals of other species". However, in the Glossary of his College Zoology (p. 700) he defines species as "a group of individuals that resemble one another closely, and whose characters are pronounced and not obliterated by intermediate forms".

Speaking by and large then we may say that, to modern naturalists, a biological species is a group of living individuals which a) exhibit the same distinctive characteristics, b) have the same parentage, c) are indefinitely fertile among themselves, but generally sterile with members of any other species.

2. B. D. Jackson, in his Glossary of Botanical Terms, defines species as "the aggregate of all those individuals which have the same constant and distinctive characters". Such simplification, which reduces the three elements of the commonly accepted definition to one, is not altogether un-

justified. For the key phrase of that is evidently the first *the same distinctive characteristics.* As a matter of fac naturalists from the beginning sought to classify plants an animals with this idea of species in mind.

However, when the definition was put to the test in actu field work, two problems forced themselves on the researcl ists:

a. The first was: What *degree of resemblance* was nece sary between individuals so that they could be called "tl same" or "perfectly alike"? Must they be as like as tw peas or as identical twins? Could they be unlike to som extent, and if so, how much?

It soon became evident that some latitude had to b granted. But where to draw the line between like and un like? Between species and races or sports? Consider mer ly the ordinary dog. What a variety of size, weight, coa head, paws etc. Yet naturalists packed them all into or species. On the other hand, compare the cat with the lic or tiger or leopard. What outstanding difference is ther between them except size? Yet zoologists refuse to put ther in one species.

b. Another problem also clamored for attention: Whic precisely are those *distinctive characters* for which the r searchist was to look and which he was supposed to com pare? Morphology was, historically speaking, the first sc ence to be consulted. Identity of animal species was pro nounced upon perfect likeness of the anatomical structur and Linné classified plants according to the number of st mens and pistils.

But at an early stage, naturalists realized that one mo phological feature was not enough. They therefore com bined a number of such features and evolved the concept o the *plan* (Cuvier) or *type* (von Baer).[2]

[2]Cf. A. Agassiz p. 25-8; Locy p. 326.

The plan or type was conceived as a multitude of morphological characters which form a *whole,* so that from the presence or absence of one we may argue to the presence or absence of others. It was based on Cuvier's law of the correlation of parts: "Every organism is a whole, a closed system, whose parts correspond one with the other and, by action and reaction, cooperate toward one effect. None of these parts can change without the others changing. Each part is related to and determines the others. Hence, if one knew the laws of organic growth, he could build up an organism from any of its parts". A famous example is Cuvier's dictum: "Hoofs on the feet indicate molar teeth with flat crowns, a very long alimentary canal, a large or multiple stomach, and a great number of relations of the same kind".[3] J. St. Mill must have had the same idea in his mind when he wrote: "By a Kind we mean one of those classes which are distinguished from all others not by one or a few properties, but by an unknown multitude of them; the combination of properties on which the class is grounded, being a mere index to an indefinite number of other distinctive attributes" (System of Logic, Bk. 4 ch. 6 n. 4).

c. As time went on, systematists began to mistrust purely morphological or anatomical classifications, turning their attention more and more to physiological features. Plants and animals were to be compared not only for their structure, but also and especially for their physiological functions. As a result, also the concepts of "plan" and "type" were enlarged so as to include the latter features.[4]

3. Even so, the course of true science did not run smooth. The great German zoologist R. Hertwig confessed at the

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[3]Cf. Janet p. 46-8.

[4]Janet p. 48-9. Note that modern naturalists use the word "type" in a different sense altogether. Cf. E. Mayr p. 12-6; Webster s.v. type specimen.

beginning of the present century: "Up to the present tin neither by physiological nor by morphological evidence h there been successfully fixed, in a clear and generally a plicable way, a criterion which can guide the systematist deciding whether certain series of forms are to be regard as good species or as varieties of species. Zoologists a guided in practice rather by a certain tact for classificatic which, however, in difficult cases, leaves them in the lurc and thus the opinions of investigators vary" (p. 30).

And plenty of such difficult cases were encountered the newly discovered fauna of Australia. What was the ol fashioned naturalist to make of an animal like the platypı which has a duck's bill, a fur coat instead of feathers, fo webbed feet instead of two, poison spurs on the hind le of the male, and is equally at home in the water or on lan Is it any wonder that the zoologist who saw a specimen the British Museum, thought it a practical joke? If he h been an American, he would have exclaimed: There ai no such animal. Other Australian animals defying t naturalist's rules of thumb were the koala, the living Ted Bear, the house-building rodents, the barking and cycli lizards, the dingo, the wombat, the spiny ant-eater e Australian black swans forced British logicians to modi their rules of scientific induction.

THE EVOLUTIONISTIC CONCEPT

The situation has been complicated by the theory of ev lution. J. B. Lamarck was the first to introduce a fund mental change. Up to his time, the constancy of speci characters had been assumed to be absolute, that is, u changeable from generation to generation. Lamarck adm ted only *relative constancy* and defined species as a colle tion of individuals resembling each other, and reproduci

their like by generation, so long as the surrounding conditions do not alter appreciably.[5]

Modern evolutionists go further. They substitute for distinctive characters *common origin.* A species is to them a group of living beings which have all descended from the same common ancestors. As a result, evolutionists and non-evolutionists no longer speak the same language, or rather, while using the same terms, they mean things very different. For, according to non-evolutionists, all the members of a species have the same distinctive characters; according to evolutionists, while the original ancestors and their immediate descendants had the same characteristics, there was a gradual differentiation into groups whose characteristics were no longer the same.

As this change caused a great confusion of ideas and would have made older classifications obsolete, a distinction was introduced. A *natural* species was the aggregate of all living beings descended from common ancestors; but each of the groups which branched off in the course of ages, was called a *systematic* species. One natural species then could comprise many systematic species, and what is now one systematic species might, in the course of time, be differentiated into other systematic species.

We shall return to this distinction in chapter 7.

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[5]Cf. Lyell II p. 247; infra p. 70-1.

CHAPTER 6

Attitude of Modern Scholastics

Modern Scholastics, when confronted with the probl of the definition of species, found themselves in a qua dary. On the one hand, they saw no reason for abandoni the time-honored definition of their predecessors. On t other hand, not being scientists by profession, they we bound, as far as a more accurate knowledge of nature we to rely on the testimony of naturalists. But their definiti of species varied considerably from that of the old Schol tics. Who then was right, Aristotle and the old Scholasti or modern naturalists? The old definition had the advanta of being not only clear-cut and logical, but also of bei serviceable in philosophy and theology; but the new defi tion, though far from univocal, was based on a wide know edge of facts, and Scholastics always bowed before facts.

It is interesting to watch the efforts of modern Schol tics to find a way out of this dilemma.

1. In general we may say that modern Scholastics *acce both definitions*. That is to say, when discussing the phi sophical term "species", they invariably hark back to t voice of antiquity; but when discussing the biological te "species", they take, with slight modifications, the defi tion current among naturalists today.

As these two assertions are of some importance, let r substantiate them by a few quotations.

a. Th. Harper, the renowned metaphysician, identifi species in the strictly metaphysical sense with "the integ essence of a thing" (II p. 514). Urráburu writes: "Spec est natura vel ratio quae de pluribus numero diversis pr dicari potest tamquam essentia eorum completa" (I p. 49(Using the same scholastic terminology, Donat says (Logi

p. 70): "Species (Art, espèce) est id quod de pluribus individuis praedicatur in quid completum seu ut eorum essentia completa". Beraza, too, writes (p. 436): "Species est ratio vel complexus notarum quae de pluribus numero diversis praedicari potest tamquam essentia eorum completa" Palmieri says (p. 280): "Unitas specifica naturae alicuius hoc pacto a philosophis spectatur ut dicantur plura individua ad eandem specificam naturam pertinere quae iisdem constant essentialibus notis" J. de la Vaissière (Phil. nat. I n. 90), J. S. Hickey (I p. 26), Glenn (Introd. p. 78, 175) substantially agree with these definitions. G. H. Joyce (p. 123) defines species as "the sum of the essential attributes of an entity". Ch. Coppens (p. 14) defines it as "all that constitutes the common nature or essence of a class of objects". C. Boyer looks at it from another angle, but he means the same thing (p. 98): "Ea entia sunt diversae speciei quae diversam habent essentiam".

b. Modern Scholastics are, of course, acquainted with the three notes of the biological concept of species enumerated above (p. 37); when working out their own definition, some take one, some two, some all three. Thus P. Schanz says (I p. 266): "Common descent, actual or possible, is the foundation for the concept of species, mutual fertility its criterion". The Manual of Modern Scholastic Philosophy by Cardinal Mercier (I p. 233) practically agrees with this: "A species in natural history denotes a series of living beings that have come from a common stock and are inter se fertile". Elsewhere, however, only one element is mentioned (II p. 148 note): "Species designates a group of individuals which are inter se fertile". Ch. Coppens, too, is satisfied with this single element: "The crucial test by which the distinction of species is known, is this: if animals can be paired together and thus propagate an indefinitely fertile offspring, they are of the same species; else they are not". S. A. Lortie (II p. 117) remarks that while philosophers

mean by species an essence common to many, naturalists d fine it with the help of a property which manifests it, vi indefinite fertility; he therefore defines the botanical an zoological species as a collection of individuals which ha the same ancestors and are capable of indefinitely prop gating their like.

Instead of common ancestry other Scholastics take sim larity of characters for their definition. Thus S. de Back (I p. 228) says that naturalists describe biological speci by two marks: unitas typi organici and indefinita fecund tas, but he words his own definition so as to make the secon seemingly a corollary of the first: "Collectio individuoru quae, cum in eodem organico typo conveniant, origine praebere possunt indefinitae seriei individuorum similium In the end, however, he rallies to indefinite fertility as th surest criterion of true species, while admitting that it not applicable elsewhere. Urráburu (I p. 489) pleads fc "complete essence" as the real definition, and as for th definitions given by the naturalists of the 19th century, h says that they could be reduced to two elements: likenes and common descent. Beraza agrees with this reduction (436-7): "Indefinita propagatio per generationem, et simil tudo individuorum secundum externam corporis forman semper habitae sunt tamquam duae notae quibus distinguur tur species". Palmieri (p. 80) also says that zoologists la down two characteristics of identity of species: likeness c qualities and indefinite mutual fertility. P. J. Glenn's defin tion is about the same: "In a biological sense, a species is class of living bodies, the members of which are similar i structure, and can breed indefinitely in their natural state (p. 304). O'Toole's long definition (p. 4) amounts to n more, except that he inserts the hardihood to survive unde natural conditions. V. Remer says (p. 47-8): "The chie difficulty of the question of evolution is the definition c

(biological) species". He then gives the following: "A group of individuals more or less alike and capable of indefinite fertility", but adds at once that he does not regard it as a strict definition, and that he accepts it only in default of a better one. He ends on a note of discouragement: "Inde patet praesentis quaestionis (i.e. of evolution) difficultas, imo quasi impossibilitas eam a posteriori dirimendi". T. Pesch builds his long definition of species on two elements: marked gaps and indefinite fertility (Psychologia I n. 175; Welträtsel II p. 243). But he does not regard it as final: "An unobjectionable concept of species has not yet been found, or rather we know of no infallible criteria for distinguishing true species from mere varieties" (Welträtsel II p. 260). Monaco, who enters into the question rather thoroughly, defines the "physiological" species as "a collection of living individuals which exhibit the same powers and type and transmit them by means of generation" (p. 210, 649).

Père Vigouroux (III p. 315) joins the three elements contained in the foregoing definitions: "Species is a collection of individuals which have the same essential characters, are descended from the same original couple, and have the power of indefinite reproduction".

2. But now comes the real problem: What is the *relation* between the two definitions of species, the philosophical and the biological? Some (like O'Toole) seem to be unaware of this problem. Among those who have faced it, we may distinguish a threefold attitude.

a. Some sidestep it by saying that biological species have nothing to do with philosophical species, that the term "species" is *equivocal,* having an altogether different meaning in biology and philosophy. Such was the position of E. Wasmann (p. 296) and of his pupil, H. Muckermann (in Cath. Encycl. s.v. Evolution). It agrees with Mill's dictum

that "the word species is used in a different signification : logic and in natural history" (System of Logic, Bk. 1 c 7 n. 4).

P. Coffey (I p. 79-81) defends the same position again Fr. Clarke. He knows that to Scholastics species mea "the whole specific nature of the individuals within th class"; but, he asks, what has that to do with biological sp cies, which is "a group of individuals supposed to have d scended from common ancestors and to be indefinitely fe tile in breeding among themselves"? One wonders that keen philosophical mind like Coffey's did not find the answ to his own question. After all, a thing may be defined fro various angles, and scholastic logic, of which Coffey wro a standard text-book, knows not only essential definitions

It would not be enough to say with Monaco (p. 210) th such an attitude would make the philosophical definition species useless, but certainly botany and zoology would set adrift in an uncharted sea, and philosophy could no long boast of having all reality for its field of operations.

Like E. Wasmann, P. M. Périer, a French savant, disti guishes between the "species of the naturalist" and t "metaphysical essence of philosophy", and after warning not to identify the two, he asks (Revue Apol. 1937 p. 275 "Why could not the latter have a wider extent than the bi logical species, which the greatest scientific authorities a unable to delimit?" Similarly, Zahm (p. 313-9) and Ag (p. 66) distinguish between metaphysical or logical speci which they regard as immutable, and physiological speci for which they make no such claim.

Wasmann, Périer, Zahm etc. invented their distinction leave a loophole for evolution. It stands or falls with th theory.

b. Other Scholastics are optimistic enough to identi von Baer's *types* with true philosophical species. de Backe

definition of species seems to imply it. G. H. Joyce after quoting Fr. Gerard's description of the cock chaffinch as a good example of a type, goes on to say (p. 386): "The conclusion seems forced on us that the complicated system of characteristics, of which the type consists, constitutes in each case a morphological unity. The type is not merely an average standard, to which the members of the class approximate more or less roughly, some of them lacking some of the characteristics, and some lacking others. These characteristics unite to form a whole, and each such whole is a closed system in itself".

We shall see by and by that this is an oversimplification. Biological species as described by naturalists, whether built around the type in the older or the modern sense, cannot at once be identified with philosophical species.[1]

c. Lastly, we have the pessimists, who see in the present awkward situation a sign that the problem of species is really *insoluble*.

J. Fröbes, undoubtedly the greatest Catholic psychologist of modern times, is of this opinion. Analyzing the process by which we must learn to know the species of nature (Psych. spec. II p. 42), he says: "The child at first perceives only the individual sense object. Later, by comparing it with other objects, he recognizes its properties, especially those which are practically useful. Some of them may gradually emerge as more fundamental than others. But since the properties and possible effects of anything can never be exhausted, his concept will always remain *incomplete*. Look at the concepts which people generally have of animal species,

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[1]Catholic Neo-Lamarckians (Wasmann, Frank, Vialleton, Boyer etc.) make the distinction, unknown to science, between the formal and the structural or organizational type, and declare only the latter to constitute a true species. We shall return to this distinction further on (p. 219-220).

such as the horse or the cow. Will anyone maintain th: this is complete knowledge? Even so-called scientific defin tions contain only a few notes, chosen for practical reason: and what is proudly hailed as scientific progress, merel consists in further refinement of such concepts". Fr. Fröb wrote this in 1927; that he has not changed his mind, clear from his Tractatus Logicae formalis, which appeare in 1940 (see quotations in Divus Thomas 1942 p. 10-11 We meet here with the specter of complete knowledg which has given a headache to many another Scholastic a it had to John Locke.

G. Sortais also deplores the essential incompleteness c our information on things of nature (I p. 699) and poin out three great obstacles which every attempt at a solutio of the problem of species must face: insufficient observation impossibility of experimentation, the flexibility of natur He is convinced that no solution will ever be more than ap proximate.

W. R. Thompson, F.R.S., writes in a like pessimist strain in an article on "Evolution and the Concept of Spe cies" (*Dublin Review* 1934): "Whether the definition c natural species is even possible, is perhaps open to questio The enterprise is obviously surrounded with difficulties, an the problems involved are perhaps insoluble" (p. 205). An he ends his all too brief article on a note of futility: "Tha such things as natural species exist in the organic worl seems undeniable, but their definition constitutes a proble of almost transcendent difficulty". As we saw above (p. 44 5), Fr. Remer's attitude is the same.

Thomists, such as R. Garrigou-Lagrange (Acta Pon Acad. Rom. 1935 p. 194) and J. Maritain (in Foreword t Adler's Problem of Species p. x) also pronounce the prob lem insoluble, but for an altogether different reason. The argue that the essences or the essential differences or th

specific forms of plants and animals are, in the last analysis, *unintelligible,* because they are so completely immersed in matter.

This essay is written in direct opposition to the pessimists. But I shall not now delay to answer their difficulties; they will be taken care of as we go along.

CHAPTER 7

Preliminary Distinctions

The last three chapters were historical for the most pa presenting the views of various scholars, past and prese on the definition of species. We must now take up the pro lem *in itself,* and we begin by introducing some distinctio which, while not meant as the ultimate solution, ought correct a certain confusion of ideas that is widespread.

1. PER SE AND PER ACCIDENS

This first distinction, taken from philosophy, always w and is very familiar to Scholastics, but somehow has nev been acclimated in English-speaking countries. Our dictio aries only give a literal translation, rendering "per se" "by itself" and "per accidens" as "by an accident". But t is of little help, since neither translation conveys the wea of meaning contained in the distinction.

Though the expressions are adverbial in form, yet "p se" is best rendered as "natural" or "essential", "per ac dens" as "non-natural" (which is not the same as "unn ural) or unessential. In general, what pertains to the nat or essence of a thing or flows from it, is said to be or ha pen per se; all else is or happens per accidens.

An example or two may illustrate the distinction. A m may stand on his feet or on his hands. He stands per se his feet, because they were given by nature for that pu pose; the hands were given for other purposes. Likewi it is per accidens when a man has 6 fingers or is cl footed; such cases are clearly exceptions to the rule rather to the biological law. So are the biological fre and curiosities exhibited in the circus—"lusus naturae", ancients called them.

Though the distinction is fundamental to any sane philosophy, it is not always easy to draw in concrete cases. But it supposes that one admits and can make the distinction between essence (nature) and accident. We shall say more about essences and their knowability in chapter 14.

2. SPECIES AND INFRA-SPECIES

Independently of all controversy, a biological species may be defined as a *lowest natural* or essential division of living organisms. It is the "species infima" or "species specialissima" if you will, and when analyzed, the scientific research for species really aims at discovering such divisions among plants and animals. Species are opposed on the one hand to higher natural divisions (genus, family etc.), on the other to divisions which are no longer essential.

Infra-species are divisions *within* a definite species. They are today called varieties, taking that term in a very wide sense so as to comprise stocks, races, breeds, sports etc. They do not modify the species itself; they are accidental to the species, not essential, and so we come back to the preceding distinction. Scholastics called the differences between them "individual". We shall say more about them in chapter 10.

3. NATURAL AND SYSTEMATIC SPECIES

We came across this distinction when speaking of the theory of evolution (ch. 5). Others besides evolutionists also use it occasionally. But as it is of far-reaching importance for our further discussion, and is yet understood differently by different authors, we must dwell on it at greater length.

1. As understood in this essay, the distinction refers to *our knowledge* of species. A natural species is a group of organisms which, on experimental and philosophical

grounds, has been *shown* to be a lowest natural division. Sy tematic species, on the other hand, are *provisional,* tentati groupings, made for the purpose of coordinating our e perimental knowledge for the present, but laying no clai to finality. They are *hypotheses*—to be ranked among nat ral species or rejected as they stand up or break dow when the tests for lowest natural divisions are applie to them.

2. As far as the terms go, this distinction is somewh arbitrary, though the thing behind it, the distinction b tween a mere hypothesis and an established fact, is a mitted by all. However, while the distinction, again as f as the terms go, is rather common today, especially amon modern Scholastics, it is not always taken in the same sens This obliges us to look at some other explanations.

a. E. Wasmann deduces the distinction from the scien tific theory of evolution which he accepts. Natural speci to him are those originally created by God, to which wou apply Linné's dictum: "Tot numerantur species quot a initio creavit infinitum ens". But "each of these natural sp cies has in the course of evolution differentiated itself in more or less systematic species"; "systematic species of th present time . . . are the result of the process of evolution" the natural species in the concrete, therefore, comprises a the members of the same line of ancestry or pedigree.

Wasmann's distinction was taken over by some Schola tics: de Sinéty (Dict. prat. s.v. Evolutionnisme col. 10 103), Donat (Cosm. p. 360 note, though in the body of th chapter he gives our definitions), R. E. Brennan (p. 295-6 Gemelli (cf. Monaco p. 241-7). Except that the terminolo gy is reversed, H. de Vries' distinction between systemat and elementary species seems to coincide with it (p. 247; c Donat, Cosm. p. 361).

Since the peculiar meaning of the distinction is draw

from the scientific theory of evolution (Lamarckism), it stands or falls with that theory (infra p. 100-5, 215-226). But it certainly is not our meaning of the distinction.

b. Some Scholastics: T. Pesch (Inst. Phil. nat. n. 594), Willems (II p. 210), Rüschkamp (in Stimmen der Zeit, May 1936 p. 230) etc. simply identify systematic species with varieties, so that the differences between them would be accidental. Now while this may be true of some or many of the species put forward by naturalists, it is not our distinction. Systematic species to us are provisional; further investigation is needed to decide whether they are true species or mere varieties.

It is not clear if Fr. Boyer (p. 98) understands the distinction in this sense or in ours.

c. P. Coffey, following J. St. Mill (System of Logic, Bk. 4 ch. 7 n. 2), does not use our terms, but distinguishes between natural and *artificial* classification (Log. I p. 80, 122-131). Natural classification, according to him, serves a general purpose, viz. to secure a better speculative knowledge of the things classified. Artificial classification serves a particular purpose, as when physicians divide herbs into medicinal and non-medicinal. But whatever may be said about this distinction, it is not ours. Our principle of division is not so much the purpose of classification as its rigorous and truly scientific character.

CONCLUSION

Two remarks may fittingly close this chapter.

1. As, apart from the human species (see last chapter), no division of life has yet been demonstrated to be a natural species, we shall, from the outset, call the species described in our manuals of botany and zoology *systematic*. This is not condemning them. It does not mean that none of them are natural species or that they are mere "working hypo-

theses". But it is a case of methodical doubt. It means tha they will not be accorded the status of true species unles they have first passed the rigorous test of logic, epistemolo gy and ontology.

Which is another way of saying that philosophy is agai to assert its time-honored role of queen of the sciences.

2. The problem of *evolution* is concerned with natura not with systematic species. The issue between fixists an evolutionists is not whether systematic species are mutab or not, but whether natural species have changed in th course of the earth's history. Nothing is more fundament to the whole debate on evolution. Everyday experience tel us that plants and animals may undergo changes, sometim profound changes. None perhaps has done more to co vince the scientific world of this fact than Darwin; none pe haps has experimented more to prove it than Luther Bu bank. But what is the net result? Modern science may ha proved or can prove that the range of mutability within bo kingdoms is much wider than our forefathers dreamt, that the influence of environment is far greater than w formerly thought possible, or that artificial crossings ar experiments can result in startling effects. But no case evolution can lay claim to certainty unless it is shown go beyond the possible limits of infra-species variation.

It will be front-page news when a naturalist, conscious the distinction between systematic and natural specie proves the transformation of one *natural* species into a other or the breaking up of one into more.

CHAPTER 8

Natural Divisions

This chapter is theoretically one with the next two; but practical reasons made it advisable to distribute the matter over three (rather unequal) chapters.

After the third distinction made in the last chapter, the next question is: Are there natural species within the two kingdoms of plants and animals? Or is there perhaps ground for the assumption that all plants constitute only one natural species? Or all animals? But keeping in view the difference between natural and systematic species, we should rather put the question this way: Is it possible to *prove* that certain divisions among plants and animals are natural, not merely systematic species in our sense? And if so how?

1. INEFFECTUAL ARGUMENTS

For an answer to this question we do not appeal to *Scripture*. Moses indeed says in the first chapter of Genesis that God created plants and animals, each according to its own kind, and he enumerates some of them: grasses and fruit trees, fishes, birds and reptiles etc. But there is no warrant for saying that he meant species in the modern technical sense. His aim being to illustrate creation, he could be satisfied with class names popularly current in his day.

Nor do we appeal to *Aristotle* or *St. Thomas*. Our main appeal must be to nature itself, or, if you will, to what modern naturalists, practical and scientific, tell us about nature. So far as the subject of this essay goes, they know a thousand times more about the facts of life than did all Greek philosophers or all medieval Scholastics combined, and "ex-

perimentum solum certificat in talibus", as Albert the Grea said.[1]

However, one who believes in scholastic philosophy might think that there is only one way of proving th existence of natural species, viz. by means of *essences*. Fo if species is the complete essence of a group of individual as all Scholastics hold, determination of natural specie would seem to depend on showing their essential differ ences. Unfortunately, this a priori method, though excel lent in itself, is inapplicable here. While the method is per haps congenial to the angelic mind, the human mind mus in these matters proceed a posteriori.

Finally, some (e.g. Willems II p. 213) argue that ther must be true species among plants and animals becaus otherwise botany and zoology would not be *sciences*. Bu such an argument puts the cart before the horse. Of cours no universally valid assertions, such as science argues from can be made concerning classes of plants and animals i species are non-existent. But whether such assertions ar possible, depends on the existence of essential and specifi divisions, not on the desire of botanists and zoologists to b reckoned among the scientists.

2. NATURAL CLASSES

If the biological species is a *lowest natural division* o living organisms, it stands to reason that, to prove a grou of organisms to be a species, we must prove that it is a natural, not accidental or artificial, b) lowest, not furthe divided into similar natural groups. If the division is natur al, it is necessary, per se and pertains to the essence of th

[1]As I pointed out in *America* (Aug. 3, 1940 p. 471-2), the funda mental defect in Adler's attempt to settle the problem of species, wa that Aristotle and St. Thomas were consulted on a question whos solution can only be found in the book of nature.

group; if it is also lowest, it is that kind of division which is properly called species in opposition to higher divisions, such as genera, families etc. Similarly, to prove that organisms belong to different species, it is necessary that the differences between them are natural and lowest.

Are there then such divisions among our plants and animals?

In this chapter we shall not give a complete answer to this question, but confine ourselves to proving the existence of *natural divisions* among them, without clearly excluding divisions higher than species. And as examples we quote from among plants: our ordinary cereals such as rye, wheat, oats, barley etc.; vegetables such as potato, turnip, beet, squash, radish, strawberry, cucumber etc.; flowers such as tulip, daisy, dandelion, rose etc.; fruit trees such as apple, pear, plum, cherry, peach etc. As examples of the animal kingdom we may take cats and dogs, horses and cattle, hens, geese and ducks, goats and sheep, turkey and guinea fowl, mice and rats, foxes and rabbits. Man has always lived in intimate contact with these creatures. In fact his life depended on them in many ways; without the right method of handling them he could not have subsisted. Hence the experience on which such deductions rest, is as wide as the world and as long as history. Scientific investigations are no more necessary to establish the facts than they are to prove gravity. The North African farmers did not have to wait for St. Augustine to tell them that beans do not sprout from seeds of wheat.

Now this age-long experience assures us that the classes mentioned are *natural,* not accidental (infra-species) or artificial. Nature itself takes care that they are, and that they remain what they are. Let us analyze this fact of experience.

1. We take as our first proof the facts of *reproduction.*

a. Transmitting for the present the question of origin we must avow that nature takes care that these classes con tinue in existence. But since all organisms must die, na ture makes sure that new individuals are not lacking. Th mechanism for this consists in reproduction. New individual originate from previous individuals of the same class, an that at a rate which corresponds to the mortality of the class The abundance of seeds in the vegetable kingdom and th overpowering sexual urge in the animal kingdom assure th desired result.

But the general term "reproduction" is too colorless t give a fair idea of nature's complicated machinery. Regard ing plants, N. Taylor says (p. 116): "In all plants, both the flowerless ones and those producing flowers, the pro cess of reproduction is carried to a perfection almost un believable in its intricacy and provisions against failure" The process is ingenious enough where it consists in self fertilization; but nature's ingenuity appears at its bes where cross-fertilization is the only method available. On might almost say that in the latter case nature will mov heaven and earth to insure the perpetuation of her plan divisions. And the process is diversified for each class. In animals, each of the classes enumerated above require different conditions for the rearing of offspring. These con ditions must be met by nature and they are met, as experi ence testifies. And while not every individual egg or foetu may reach maturity, yet the divisions are kept alive.

b. Animals cannot as a rule be perpetuated unless th mature individuals keep on living for some time. That mean *eating*. Now in contrast to the plant world, the food suppl for animals is limited. If all birds had to live on grass hoppers, there would soon be neither grasshoppers no

[2]Cf. N. Taylor p. 123-154, 340-8; W. Heath, in *The Catholi World,* 1943 p. 401-5.

birds. But nature provides each division of animals with its own menu and with an instinct for procuring the items on it. In those animals, moreover, which undergo metamorphosis, the problem of the menu becomes vastly more complicated. Each stage of the life cycle demands its own food with little variation to make up for missing vitamins. Nature meets these demands, too, must meet them to insure the permanence of its classes and a sufficient number of individuals in each.

c. The divisions mentioned are also natural inasmuch as nature takes care that they remain as they are. Nature does not want them contaminated by interbreeding. We shall have more to say on this point in the next chapter.

2. Our second proof is taken from the *constancy of characters.*

Differentiating classes of plants and animals by means of their characters is the most obvious procedure. In this way we all differentiate between horses and cows, cats and dogs, geese and ducks etc. Hunters judge by the tracks in the snow what kinds of animals passed during the night. Disciples of Isaac Walton claim they can tell a fish by the way he tugs at the line. Botanists identify plants by their flower, their seed, their fruit, even by their leaves; for though leaves are as variable as nature itself in outline, margins, bases, tips etc., yet all these items are uniform enough in each class to be a good characteristic.

The groups of characters which distinguish the different classes (types) are also constant. However or wherever they came into being, they are known to have existed, essentially unchanged, through all the centuries comprised by history. Aristotle described many of them over two thousand years ago, and his descriptions tally with present-day observations. During the same time, billions of pre-scientific experiments have proved, positively and negatively, the

absolute constancy of these divisions. Occasional, chan
or intentional, cross-breeding has not corrupted them.

From all this, the philosopher infers a necessity, *natural law*, which positively keeps each such division going concern, and negatively prevents it from being co taminated by contact with neighboring divisions. He furth infers that there are natural divisions both in the plant ar animal kingdom.

3. Our third argument is taken from *animal instincts*.

Since instinct supposes some sort of cognition, no o ascribes it to plants; only animals have instincts. But in h commentary on Aristotle's second book of Physics (lect 13) St. Thomas has a famous passage which brings o the naturalness of animal instinct: "It is manifest", he say "that animals are not guided by reason, but by nature, b cause their actions are so uniform. One swallow's nest like another, and one spider's web is like another. Now th would not be if their activity were guided by reason an art, as we see in architects, who do not all build the houses alike, precisely because they can deliberate on th style of their product and vary it". And in his Summ contra gentiles (II c. 66) he says of animals: "Non ope antur diversa et opposita, quasi intellectum habentia, s sicut a natura mota ad determinatas quasdam operationes uniformes in eadem specie".[3]

Common sense and experience agree with St. Thoma If there is anything natural about animals, it is their i stinctive behavior. Instincts are constant, uniform, irresis ble; they are something innate and hereditary; they are n acquired by practice, as are habits; animals exercise their i stinctive functions without having learned them from the parents and without having practiced them for a time mo

[3]Cf. O'Toole p. 253-263.

or less successfully; for let us remember that without the perfect or near-perfect performance of many instinctive actions the animal would inevitably perish. Sir A. E. Shiply tells us (p. 129) that the English swallows migrate and winter far beyond the equator in Africa; the curious thing is that the young leave England some weeks before their parents, and without experience and guidance find their way to their winter home.[4]

CONCLUSION

If this is so, we can apply the scholastic axiom: Contra factum non valet argumentatio. That is to say, no a priori principle can be marshalled against the existence of natural divisions within the plant and animal kingdoms. Thus one might appeal to the methodic principle "Entia non sunt multiplicanda", or to the one already referred to "Natura non facit saltus". Or if one has a systematic bent, he might argue that as man is admittedly a natural species, so the other member of the genus "animal", viz. brute animal, must be, too. But none of such a priori considerations can invalidate the existence of natural divisions in both kingdoms of life.

[4] Cf. O'Toole p. 263-9.

CHAPTER 9

Criteria of Species

This chapter is a continuation and necessary complem of the last. The reason is that more than every-day expe ence is called for to put the existence of species on a s entific basis. While that experience suffices to establ natural classes among plants and animals, only the spec knowledge of botanists and zoologists can show which these classes are *lowest* and therefore species in oppositi to genera, families etc.

On the other hand, neither botanists nor zoologists ma a clear distinction between natural and systematic speci They invoke various criteria for distinguishing species fr species, but these criteria are either insufficient in the selves or at least disputed by other naturalists.

There is no fixed number of criteria of species. It is t aim of this chapter to examine those commonly accept and to add some commonly neglected.

1. INDEFINITE FERTILITY

1. This is really a double criterion. Positively it sa that all those individuals belong to one species which ha the power of producing identical offspring, so that these turn have the same power, and so on. Where reproducti is sexual, the criterion implies, of course, that the proge will come about through union of the two sexes. Negativ the criterion says that individuals which have not this pow belong to different species; in other words, mutual steril is a criterion of difference of species.

Since reproduction is essential to living organisms, t criterion, at least in its positive aspect, is applicable throu out the two kingdoms of life. It is also the one most wid

used among naturalists. The first to propose it was John Ray, but the first to utilize it on a large scale seems to have been J. G. Koelreuter, a German botanist. When he came across flowers which other botanists regarded as distinct species, but which on experimentation proved to be perfectly fertile together, he pronounced them mere varieties.[1] After him, systematists inserted the term "indefinite fertility" into their definition of biological species, and most modern Scholastics followed suit.

2. What is the *value* of this criterion?

a. As far as the *animal kingdom* is concerned, common sense is satisfied that indefinite fertility coupled with mutual sterility is an excellent criterion. If man's experience with domestic animals counts for anything, we may say that this judgment is backed by billions of non-technical experiments carried on throughout recorded history.

Still, to the scientific mind things appear less simple. Not only are there many crosses and mongrels, but also genuine *hybrids,* that is, offspring of what, by all other criteria, are distinct species. The outstanding example is the Kentucky mule, a cross between horse and ass. Other examples occasionally met with are crosses between hares and rabbits, goat and sheep. "The pheasant will interbreed with the common fowl, the Guinea fowl, and even with the black grouse" (J. P. Moore, in Encycl. Amer. s.v. Pheasant). Wolves sometimes breed with dogs, especially Eskimo dogs. John Locke claimed to have seen a "creature that was the issue of a cat and a rat, and had the plain marks of both about it". In Suarez' time, the leopard, the lynx and other like animals were thought to be genuine hybrids.[2]

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[1]Cf. Locy p. 412; Lyell II p. 306-311.

[2]Both Lamarck (Zool. Phil. p. 39) and Darwin (Origin of Species ch. 9) made much of reputed hybrids to bolster their theories of evolution.

But first of all, we must exclude animals which merel look like a combination of two distinct species, such as th leopard, the lynx, the Australian platypus etc. Secondly while the mutual sterility of some kindred species may no be complete, the fertility of such crosses is not indefinite The mere fact that the Associated Press thinks it news whe a she-mule nurses a foal,[3] is sufficient evidence for the state ment.[4] In the zoological gardens of East India, tigers an lions mate occasionally; but crosses are rare and short lived. Some years ago, the scientific world was startled b the experiments of Jacques Loeb, who succeeded in fructi fying the eggs of sea-urchins with the sperm of sea-stars but the results never got beyond the larva stage. Accordin to the *Reader's Digest* (Aug. 1946 p. 86), the Dominio Experimental Farm at Wainwright, Alberta, tried to cross breed buffalo and domestic cattle. It took them 25 year to produce a strain that was not sterile, and at that ther is no guarantee of productivity for the future.

Nature abhors hybrids. And therefore we see that thing are arranged so among animals that some divisions will no cross in the wild state. We know several obstacles whicl nature has placed in the way of cross-breeding: sometime two classes are natural enemies (like cats and dogs); some times the seasons of sexual heat differ too widely; some times crossing is out of the question by reason of a marke difference of organs etc.[5]

b. The claim of some few botanists (K. Sprengel) tha the majority of *plants* can be crossed and that hybrid plant are, as a rule, fertile, is without foundation. Nature abhor hybrids also in the vegetable kingdom and has provide

[3]Cf. *Journal of Heredity,* Dec. 1939 p. 548-551.

[4]Cf. Chidester p. 408. In order not to injure their theories, Lamarc and Darwin conveniently ignored the sterility of genuine hybrids.

[5]Cf. Reimarus, The Principal Truths of Natural Religion, Treatis 5 n. 26-8; Enc. Brit. s.v. Hybridism.

sundry means against them, as when the soil or the climate congenial for one plant is unsuitable for another, or when seeds mature at different seasons. Crosses which do occur are between plants morphologically so similar that one may doubt if they really belong to different species. L. H. Bailey writes (p. 46-7): "The commonest cause of sterility is the positive refusal of a plant to allow its ovules to be impregnated by the pollen of another plant. The pollen will not "take". For instance, if we apply the pollen of a Hubbard squash to the flower of a field pumpkin there will simply be no result,—the fruit will not form. The same is true of the pear and the apple, the oat and the wheat, and most very unlike species". Luther Burbank, probably the one who crossed plants on the most extensive scale, was not always successful. "In his efforts to improve the California dewberry, he crossed it with brambles, rasp, strawberries, roses, cherries, apples and pears, and never got any satisfactory result. Hundreds of Nicotianas were crossed with Petunia, but only one seed germinated. The plant was an annual, and never set any seed" (G. F. Scott p. 290-1). At Fremont, Nebraska, they raise a hybrid corn, but it does not carry over from year to year; new crossings must be made each summer.

c. *Cytology* and the study of chromosomes have brought to light a most powerful obstacle to cross-breeding. The various stages through which the new cell must pass, are so meticulously predetermined that nothing will result unless sperm and ovum are geared to each other perfectly, or unless the mechanism of the one meshes accurately with that of the other. Where tendencies are divergent, the mechanism must eventually jam and bring about the death of the new cell. What is meat for the mate of the same kind, is poison for that of another.

Therefore while the obstacles against cross-breeding may

be overcome by man's cunning or frustrated by fortuitous circumstances, genuine hybrids are, like the freaks of nature, *per accidens*. They are never intended by nature; in fact they are against the intentions of nature.

We may conclude then that naturalists were wise in claiming for true species indefinite fertility, coupled with mutual sterility where reproduction is by syngamy. But we must not infer that "no protist type is a true species", as does O'Toole (p. 5); for the main part of the criterion is the positive aspect, not the negative.

4. Scholastic readers may be interested in an objection which Fr. Urráburu raises against this criterion. He calls it "minus philosophicum", because it cannot be applied to angels and minerals (Psych. I p. 490).

The objection is not well taken. As appears from the context, Fr. Urráburu does not sufficiently distinguish between external criteria and internal constitution. Then, too, we are looking for criteria applicable to living organisms; why must the same criteria hold for angels, who are not organisms, and for minerals, which are not living? But if "minus philosophicum" merely means that the criterion is not universally serviceable, that is true.[6]

5. Therefore Harvey's biological axiom should be amended to read: "Omne vivum ex vivo *eiusdem speciei*", a truth which the Scholastics had enshrined in the axiom: "Quidquid agit, sibi simile agit". But then a distinction is in order. The proposition that life originates in every individual case from life, admits of no exception; but the addition "eiusdem speciei" must be taken as *per se,* exceptions being possible though against what nature intended.

[6]Cf. Beraza p. 437.

2. COMMON ORIGIN

1. Allied to the first, though less definite in meaning, is the criterion of common origin or common descent. It may mean that those organisms belong to the same species which are descended a) from the same parents and grandparents, or, b) more indefinitely, from the same remote ancestors, or c) from the same first parents. Negatively, the criterion would say that those organisms belong to different species which cannot lay claim to any such ancestry.

2. Its value as a criterion of species differs with the three meanings. If the first or the second meaning be taken, its force is too obvious to call for discussion. Parents and their children, grandparents and their grandchildren evidently belong to the same species, if species means anything at all; hybrids may be discounted as being per accidens. As for the pertinent negative meanings, they partake of the weakness of the third meaning.

In its third meaning, the criterion is practically useless. Who can follow the long lines of organisms back to their common ancestors? Who can trace the ever-widening and ever-changing circles of life down the geological ages? Even for man, there is a wide gap, unbridged by science or history, between prehistoric man and our protoparents. The fact is that we know next to nothing of the first representatives of our flora and fauna. We may visualize one individual or one pair at the beginning of each plant and animal division, but that is no proof that only one was originally created (or evolved, if you will). Science cannot exclude the possibility that many specimens of each species, either in one place or in many lands, came into being; and if that is so, unity of origin as meant in the criterion could not be upheld.

All that this criterion can really mean is that those organisms which we know, on other evidence, to belong to the same species, *could have* sprung from the same original ancestors.

3. Evolutionists make much of this criterion. But in their hands it becomes even more precarious, because they assume that an original species may later have been differentiated into several systematic species, so that different species could have the same ancestors. Whether organisms which we know, from other sources, to belong to different natural species, could have a common origin, is far less sure.

3. LIKENESS OF CHARACTERS

1. This criterion, applicable throughout the domain of life and beyond, corresponds to the second element which naturalists inserted, after Cuvier, in their definition of species. It means that those organisms belong to the same species which manifest the same characteristics. Its negative aspect will be discussed under the next criterion.

2. This is really the criterion developed in detail by naturalists. Their descriptions of plants and animals enumerate those features which are common to a species; and if by characteristics are meant those traits which are essential or flow from the essence, then they must, on philosophical grounds, be the same in all individuals of the same species.

On the other hand, the history of the concept of biological species is not reassuring as to the success of the procedure. Naturalists have reached no agreement either on the traits to be chosen or on the degree of likeness which would entail identity of species. Furthermore, things alike under one aspect may be very unlike under another. And now the science of ecology comes along to tell us that

totally unrelated organisms often assume characteristically similar growth forms where the conditions in widely separated areas are climatically or otherwise similar.

Nevertheless, this criterion has undoubted value. What is needed, is to find *real characteristics*, that is, traits which can only be explained as pertaining to the essence of a biological species.

4. MARKED GAPS

1. This criterion is merely the obverse of the preceding. It means that those organisms belong to different species which are very unlike or dissimi'ar in their characteristics, and especially those between which there are *no intermediary forms*.

2. What is its scientific *value*?

If used with caution and especially in conjunction with others, it has its value. de la Vaissière thought so much of it that he took it, combined with the preceding, for his definition of species. Species, he says, "est collectio individuorum talis ut individua eius collectionis non differant inter se nisi secundum plus et minus, et differant ab individuis aliarum collectionum secundum veras discontinuitates" (Phil. nat. I n. 90). By discontinuities he meant irreducible differences. He congratulated himself that he had thus found a definition of species acceptable all around.[7]

Still, not only is the criterion beset with the same limitations as the preceding one, it has three of its own. First, it is not always easy to decide how wide the gap between characters may or must be to indicate difference of species; hence the many borderline cases which naturalists seem to be unable to dispose of. Secondly, the facts of infra-species varieties (e.g. freaks, mutations, alternations of genera-

[7]Cf. Moran p. 309-310.

tions) make the application of this criterion hazardous unless other evidence be at hand.[8] Thirdly, as long as our knowledge of plant and animal forms is incomplete, we must remain in suspense lest a transitional form be found some day—either dug up by the spade of the paleontologist or discovered in out-of-the-way places, as happened when Australia's fauna became better known. L. T. More shows (p. 133-6) how the building of museums in which the fauna and flora of all countries and ages could be compared conveniently, led first to a rearrangement of classes and finally to the belief that each species merged into others by imperceptible gradations.

5. CONSTANCY OF CHARACTERS

1. This popular criterion may be regarded as a summary of the preceding three or four. It means, positively, that those organisms belong to the same species which exhibit the same characteristics generation after generation, and, negatively, that those belong to different species which manifest other constant characters.

2. What is the *value* of this criterion?

In the abstract, the criterion is certain, so much so that Scholastics build on it their proof for the validity of scientific induction. For there must be a sufficient reason for the constancy observed in the likeness or unlikeness of characters, and that can be no other than the essence; only the essence and those attributes which flow from it, are constant; all other attributes, being accidental, may or do fluctuate. Fr. de Sinéty even defines "species" in accordance

[8]In this connection let us recall that the same animals and plants show different characteristics at different stages of their life-cycle. Not realizing this, Audubon himself, the great lover of birds, thought he had discovered a new species of eagles, whereas the specimen he shot in Kentucky and described was merely a bald eagle before reaching maturity. Cf. *Sat. Eve. Post*, Febr. 22, 1947 p. 20.

with this criterion, though for sexual reproduction he also includes indefinite fertility (Dict. prat. s.v. Evolutionnisme p. 103).

In the concrete, however, things are less rosy. Not only are the difficulties of the two preceding criteria (likeness and unlikeness of characters) involved somehow in this one, but also a distinction must be made between absolute and relative constancy. Absolute constancy means that the characters remain the same or different no matter how much external and internal conditions vary. Relative constancy depends on external or internal conditions; as long as these remain, the characters remain as they are; when they change, the characters may or will change.

Of course, only absolute constancy of characters is a safe criterion of species. But is it possible to prove absolute constancy for any concrete case? Lamarck thought that it was impossible because we cannot vary circumstances sufficiently, and many agree with him. Nevertheless while we may say in general that a good deal depends on the right choice of characters, our own answer to this difficulty will appear by and by (infra p. 175).

6. CHROMOSOMES

1. Differentiating species by means of the number of chromosomes is a recent practice. To understand its factual basis, we must recall a chapter from modern biology.

Biologists assure us that every species of plants and animals has a fixed and *characteristic number of chromosomes* in its cells, into which the chromatin nucleus resolves itself prior to mitotic division, and that the number is generally *even*. Hegner (College Zoology p. 18) states it as a simple fact: "Every species of animal has a definite number of chromosomes". Also Webster's New International Dictionary says that chromosomes are "ordinarily definite in num-

ber in the cells of a given species". J. Mavor, of Unic
College, goes more into detail: "In each cell of every speci
of both vegetable and animal life, there is a constant num
ber of chromosomes, the number varying with the specie
The lowest number, two, occurs in a certain small worr
The fruitfly has eight chromosomes per cell. The highe
is perhaps found in certain one-celled animals where 16,0(
chromosomes have been counted. Man has only 48, shov
ing that the number of chromosomes is not directly relat
to the position of the animal on the tree of life" (*Scienti
American,* Nov. 1925 p. 322). H. H. Newman gives oth
detailed figures: "The form taken by the condensing chr
matin is as characteristic and specific as is the crystalli
form of a chemical compound. Not only are the shap
and sizes of the chromosomes characteristic, but the numb
of chromosomes . . . is quite constant for a given species. F
example, a certain species of crayfish has 200 chromosom
one species of water flea has 168, a species of moth has 6
man has 48, a species of salamander has 28, the pine tr
has 24, maize has 20, Lamarck's evening primrose has 1
Drosophyla (the classic fruit fly) has 8, one variety of t
maw-worm of the horse has 2" (The Nature of the Wor
etc. p. 185).[9]

2. As far as the testimonies of modern biologists go the
the number (with shape and size) of chromosomes wou
seem to be an unequivocal criterion of species. There is or
one disconcerting feature about it. Classes of organis
which belong to different species by every other test, m
have the same number of chromosomes. Thus the numb
24 is assigned to the mouse, the salamander, the trout a
the lily; man has 48 chromosomes, but so has the pot
and the onion. Still, this obscurity does not detract fr

[9]Cf. MacDougall p. 42. 702.

the value of the criterion. Nor does the existence of the sex-determining chromosome (X-chromosome).[10]

But now, if the criterion is as definite as biologists tell us, how is it that so little use is made of it in determining species? And why the modern skepticism anent the term "species"? It would be simple, so it seems to the layman, to define species as "a group of organisms with the same number (shape and size) of chromosomes". Nothing vague or uncertain about that, except for the obscurity mentioned. Moreover, it would be possible, so it seems again, to determine species with the greatest of ease. Chromosomes are microscopic, but not sub-microscopic like genes. Any naturalist then who can afford a good microscope, should be able to establish, beyond the shadow of a doubt, the existence of any number of plant and animal species. Where is the hitch?

7. THE LIFE-CYCLE

1. Also this criterion is of recent date. Hinted at by G. H. Joyce (p. 386), it has been stressed recently by a French savant, Emil Devaux. Individuals of the same species, he observed, not only pass through the same stages of evolution, but these stages are also reached about the same time of life; individuals of different species follow a different rhythm. Isochrony of evolution then is a sign of identity of species, heterochrony of specific difference. But the criterion is readily extended to the whole life-cycle, from the embryo cell to death at the normal age.

2. What is the scientific *value* of this criterion?

[10] Cf. Chidester p. 533-4, 538-9.—A similar phenomenon has been observed with regard to the body temperature. While the body temperature of animals differs from class to class and is yet constant, and so appears to be a good criterion of species, some widely separated animals have the same temperature. The animal closest to man from that angle is said to be the elephant.

It would seem to be of the highest and fairly easy of application. In all dogs, no matter what breed they belong to, the period of gestation is about 80 days, and pups born on the same day develop at the same rate and stop growing at about the same time. Cats have a different period of gestation. Again, though cats and tigers resemble each other so much, yet their period of gestation is not the same; also, a kitten and a tiger, if born the same day, develop at different paces; the kitten reaches maturity much faster, almost seven times faster than the tiger. A like dissimilarity of evolution exists between dog and wolf, horse and ass, ram and goat. MacDougall (p. 695) and Chidester (p. 465) give the period of gestation for a number of animals. Thomson's "Outline of Science" gives the evolution of the salmon (p. 197), of the mole (p. 462), of the elephant (p. 472), of the butterfly (p. 531-2), of the locust (p. 534) etc. J. G. Needham (p. 74) gives the metamorphosis of the post-embryonic frog.

R. Hegner (Parade of the Animal Kingdom p. 27-8) describes the life-cycle of the malaria parasite with its complicated series of stages. The whole of MacDougall's chapter 43 bears on the subject. But readers in New England will probably find more interest in the curious life-cycle of the oyster. R. L. Carson thus describes it in "Food from the Sea" (1943 p. 60): "Spawning usually begins early in July in New England, when the water temperature is from 60° to 70° Fahrenheit. The oyster is highly prolific. A female may produce from 15 million to 114 million eggs at one spawning, and since she may spawn repeatedly throughout a season, the total number of eggs produced in a summer may amount to several hundred millions. The fertilized egg develops into a small, free-swimming larva in only 5 to 10 hours, depending on the temperature. The oyster larvae live free in the water for about 2 weeks, and may be widely scattered by tides and currents. Larval develop-

ment is completed when the young oyster is approximately 2 weeks old and one seventy-fifth of an inch in diameter. It is then ready to "set" or "strike", as the act of attachment is called. . . . After setting, the larva (now called the "spat") quickly develops organs like those of the adult oyster and grows so rapidly that in 2 weeks' time the shell is a quarter of an inch long. . . . Once an oyster is set, it remains attached for life, unless dislodged by man or violent storms".

Equally curious are the stages through which a colony of bumble bees passes in one season. The formation of the colony begins at the end of May, when a large female constructs a cell of wax and pollen, fastens it to a piece of wood, deposits therein several eggs and then closes it. A little later an opening is made at the top through which the larvae are fed. Pupation takes place in cocoons of fine silk. The first brood hatched are chiefly workers, who now take over the job of feeding the larvae, thus leaving the queen free to lay eggs. The growth of the colony is checked in autumn, when large numbers of males are hatched as well as new queens. Thereafter the colony dies out, with the exception of a few fertilized females, who live through the winter and constitute the nucleus of a new colony for the following spring.[11]

The criterion also applies to *plants*. No farmer, no gardener, no arborist has any doubt that each species of shrub or flower or tree or cereal follows, by and large, its own period of growth and decay. And none ever conceived the possibility that one species might spontaneously adopt the cycle of another. Even similarity of climate or external factors will not produce the same rhythm of life in different species, though they may accelerate or retard the various stages (e.g. forcing plants in a hothouse).

[11] Cf. Shipley p. 155-7.

3. Of course, one must not expect absolute regularity. The laws of biology are less rigid than those of crude matter, so that slight deviations from a mean and individual differences would not invalidate them. Moreover, exceptions are possible, brought about either by untoward natural causes (freaks) or through human interference.

The student of systematics will also do well to distinguish between generic and specific life-cycles. Every beetle passes through four stages; yet when examined more in detail, these four stages will be seen to differ in different classes. Even a whole order, like the Acarina (mites and ticks), passes through the same four stages; but again there are not only generic, but also specific differences between the single stages.

8. INSTINCT

1. The term "instinct" carries a heavy burden of scientific and philosophical implications. Scientists are prone to confuse it with reflex actions, vital needs, mere tendencies, especially with habits; evolutionists shy away from it because it places a stubborn question mark after their theory. On the philosophical side, Scholastics are not agreed what kind of cognition is supposed in facts of instinctive behavior.[12]

Yet what more natural than to use instinct as a criterion of species? Why not group in one species all animals manifesting the same instincts, and, negatively, assign to different species animals with different instincts?

2. What is the scientific *value* of instinct as a criterion?

Though few naturalists make any extensive use of it and though it is applicable only to one kingdom, yet there can

[12] Cf. Gruender p. 240-300; Gaffney p. 155-248; Fröbes, Lehrb. II p. 408-416; Esser p. 104-119; O'Toole p. 247-267; Brennan, Hist. of Psych. p. 185-6, 207-8.

be no doubt that instinct is of the highest value in determining natural classes among animals.[13]

But species being a lowest natural division, we must make a distinction between *generic* and *specific* instincts. Take the wandering instinct. It is rather widespread among fishes, being found in the eel, the salmon, the trout, the sturgeon, the tuna and a host of others.[14] But if their migrations are compared in detail, significant differences appear. While the salmon goes up a fresh-water stream to spawn and die, eels go down to the sea for that purpose. Again, not all salmon follow the same pattern. "The migration of the king salmon is probably the longest of all salmon; the pink salmon migrates least of all of the Pacific salmon, since it spawns near the mouths of the streams or upstream but a few miles above salt water" (L. P. Schultz, in 1937 Report of the Smithsonian Inst. p. 365). Trout, though their migratory instinct is well developed, spend most or all of their lives in fresh water.

Only a few mammals migrate: bison, reindeer, fur seal, dolphin, bat and lemming. But many birds have the wandering instinct: storks, starlings, lapwings, swifts, swallows, terns etc.[15] Yet again, it has been established that each class follows its own route. Hunters know the time-table and the route of the different species of geese and ducks. In the *National Geographic Magazine* of June 1942, A. A. Allen, Professor of Ornithology, Cornell University, describes the peculiar routes and termini of the following birds: bobolink, belted kingfisher, wood thrush, yellow-billed cuckoo, yellow-breasted chat, prothonotary warbler, tree swallow, red-eyed

[13]While instincts are proper to animals, yet something akin to them is also found in plants. Various kinds of movement are clearly distinctive and may serve as criteria of plant species. Cf. W. Heath, in the *Catholic World,* July 1943 "The Marvel of Movement in Plants".

[14]Cf. Chidester p. 263-4.

[15]Cf. Chidester p. 366-8.

vireo, cardinal. Butterflies, too, wander from Canada to Louisiana and back along definite lanes, but their routes and seasons have not yet been sufficiently checked.

The distinction between generic and specific instincts must also be made in other cases. That the cormorant, the gannet and the pelican, in spite of their outward likeness and their common instinct for fishing, yet belong to different species, becomes evident when their fishing methods are compared. All are familiar with the peculiar instincts of ants, wasps, bees, beavers etc. But are these so specific that we must assume only one species for each, or are they further diversified?[16]

Another criterion, generic in a way, yet specific to a degree, is the method which each class of animals instinctively follows in procuring food. Many examples of specific methods will be quoted in chapter 16.

Perhaps the most appealing of all animal instincts are those which pertain to the rearing of offspring. Of course, a nest is a nest. To you, but not to the mother bird who has to provide a very specific cradle for her progeny. Zoologists assure us that each species of birds builds a distinctive nest, and nature lovers argue from the place, size, peculiar construction material of a nest to the species of which that particular bird is a member.[17] On the other hand, what can be more specific than the clever tactics by which the female cuckoo, who builds no nest, smuggles her own egg into another bird's nest? In many cases, species may be identified by the distinctive method employed in taking care of the eggs after they are laid, and of the young brood after hatch-

[16]Cf. Thomson's Outline of Science p. 408-9, 493-4, 511-531.

[17]Examples in Thomson's Outline p. 203, 438-443; Encycl. Brit. s.v Nest; Chidester p. 365-6; Gaffney p. 158-171. Or read the accoun of the nest-building, spawning and post-spawning activities of the salmon and the trout in the 1937 Report of the Smithsonian Inst p. 365-376.

ing. Good examples are the obstetrical toad and the Surinam toad.[18]

There is one animal instinct, general so it seems and yet essentially specific, to which A. Scheinfeld has drawn attention in *The American Mercury*, March 1945, p. 302-9. No male animal fights the female of his own species. One acquainted with domestic animals (dogs, cats, horses, cattle, poultry) knows this from daily experience. Circus trainers and zoo officials are unanimous in confirming it; the males of apes, lions, tigers, elephants, deer, seals etc. will fight with other males at sight, but not with their own females. The value of this instinct as a criterion of species is enhanced by two of its characteristics. First, the instinct extends only to the females of the same species. A tomcat will pounce upon any mouse that sticks its neck out of the hole, whether it be male or female; a male lion may be gentleness itself to a lioness, but he will not hesitate to maul a female zebra, sheep or ostrich. Second, this male chivalry extends to all females of the same species. No distinction is made as to race or color or appearance. "The purebred white male bulldog is just as chivalrous to a black or yellow nondescript female mongrel dog of any type as to his pedigreed sister".

Nevertheless, in spite of the numerous examples in which the proposition is true, investigation has probably not yet covered a wide enough field to pronounce it universal.

CONCLUSION

Not all of the eight criteria are equally useful for establishing true natural species. The second, third, fourth and fifth, though relied on mainly by naturalists, are too vague to furnish apodictical proofs, positively and negative-

[18]Cf. Thomson's Outline p. 212, 217.

ly, as the history of the concept of species shows. But the other four are so univocal that specific identity or diversity can be safely deduced from them. They are: indefinite fertility coupled with mutual sterility, the number of chromosomes, the life-cycle, specific instincts.

There is then no reason to be pessimistic and to pronounce the problem of species insoluble, at least as far as the mere *existence of natural species* goes. The plant and animal worlds are actually divided into natural species, meaning lowest natural classes.

The older *Scholastics* never doubted the existence of species.[19] Most modern Scholastics agree with them. P. J. Glenn, for instance, asserts categorically: "That there are different species of living things, and of animals, needs no proof" (p. 304).[20] Fr. Harper (II p. 541-561) wavers on account of the axiom: Natura non facit saltus. But his arguments, mostly drawn from genetics, are unconvincing. Certainly his concluding statement "first a thing is 'animal', then 'horse' ", even if taken from Aristotle, has been proven false in connection with Haeckel's famous photos.[21]

But it would be advisable for modern Scholastics to familiarize themselves with the various criteria which science has brought to light. Fr. Donat, who is most up-to-date on the subject, knows that the number of chromosomes is fixed for each species (Cosmol. p. 197), but he nowhere appeals to it as a good criterion of species. Fr. Monaco, too, states the same biological fact (p. 137), without being aware of its implications. Where he discusses the criteria of species (p. 209-210, 250-1), he only speaks of proper activity, distinctive type and identity of offspring, but finally reduces them to the last.

[19]Cf. Suarez, Disp. Met. D 15 s. 1 n. 18; idem, De opere sex dierum II c. 7, n. 8.

[20]Yet on p. 96 he says: "The points in which the various plants differ are non-essential or accidental".

[21]Cf. Monaco p. 238-9.

CHAPTER 10

Infra-Species Differences

Species are lowest natural divisions. Yet within the plant and animal species commonly recognized as such and confirmed by the best criteria, there are diversities, some of them so striking that they have been declared essential and specific. In this brief chapter we shall enumerate the principal classes of such diversities, and show that they are non-essential, non-specific, infra-species, and therefore do not destroy the unity of the species.

1. The first kind are *purely individual* differences. No two plants of any kind, no two animals are exactly alike. Even abstracting from extrinsic relations (e.g. place, time, parents), we find everywhere dissimilarity in shape, size, color, vigor etc. Obviously, unless every living organism is to be called a species by itself, such differences are infra-species. They are mere varieties. Most of them are trifling by every standard, and the Scholastics never rated them higher than accidental.

2. We may call *ontogenetic* those differences which appear in the gradual evolution of one and the same individual from the first cell till death. Well-known are the profound changes which the beetle undergoes in a lifetime. Beginning as an egg, it turns into a larva and then into a pupa; the end stage is the imago. Certain aphids or plant lice assume as many as 21 different forms during a life-cycle. But the phenomenon is really universal in the organic world. There is a decided difference between the egg, the embryo, the fetus etc. of any animal, as well as between the early stages of a living plant.

Some have called these stages species, so that each animal and plant would, in the course of a lifetime, pass from

species to species. This is an abuse of language. Every in dividual remains within the same species throughout it life; else there would be no reason for the predetermined sequence and isochrony of the stages through which i passes.

This explanation gives us a clue for judging of two other classes of striking phenomena which modern science has unearthed.

a. When conditions for continued growth become unfavorable, some bacilli turn into "spores" or *"resting cells"* This is not a new method of reproduction (as in some low form of plants), but a means of self-protection. The bacill in this state can better withstand destructive influences, such as heat, sunlight, chemicals etc. On the return of more favorable conditions, the former state of existence is resumed Therefore the difference between bacillus and spore is only accidental.[1]

b. Another surprising phenomenon is heterogenesis or *alternation of generations.* It consists in this that the mode of reproduction varies between sexual and asexual (as in mosses and liverworts), or that some generations look morphologically, like different species. Yet there can be no doubt that such variations are infra-species. The movement as a whole is within a closed circle; the single step are predetermined for each species, and there is no tendency to another definite species.[2]

Here we may add something on the peculiar *sex-chang* which has been observed in some oysters. "Individual are normally at one instant either male or female, but they change from male to female, and back again many time during life. Hermaphrodites, however, do occur in varying proportions, but usually function as females" (Encycl

[1]Cf. MacDougall p. 675.
[2]Cf. Locy p. 432-3; Shipley p. 167-175.

Brit. s.v. Oyster p. 1003). But these antics do not change the oyster into something else, nor do they indicate a difference of successive species.

3. Of deeper significance are *functional* differences. They arise when any of the three essential functions of vegetative life (nutrition, growth, reproduction) are distributed among different individuals of the same kind. The best known example is the division of male and female where reproduction is sexual. Other examples are found among bees, ants, corals, sponges etc., in which the various organic functions are distributed among different members of the hive or colony.

There have been some who called such differences specific, but their view was never widespread and cannot be defended at the bar of reason. The differences are real and natural enough, but they are demanded by the species as a whole. The two sexes e.g. are so interdependent for reproduction that the whole species would perish if either were to disappear. As we shall see, even their relative numerical strength is carefully regulated by nature with a view to the well-being of the species as a whole.

4. Far more vital to our problem are *racial* differences. I mean not only those characteristics which mark off races properly so called, but also those which distinguish breeds, strains, stocks etc. They constitute the most serious phase of the problem of species, because, being hereditary, they resemble specific differences to some extent.

Of course, slipshod writers and lecturers will use the words "species" and "race" as synonyms. Accurate speech, however, differentiates them, as every dictionary points out, and the difference is based on difference in heredity. Racial differences can be acquired and lost, specific differences cannot. R. W. Murray correctly defines a race as "a relatively permanent variety possessing very similar hereditary

physical characteristics" (p. 109). Specific differences on the contrary are absolutely constant.

Botanists and zoologists speak indeed of "fixing" or rendering "permanent" certain traits which have appeared unexpectedly in a plant or an animal, or which have been induced artificially. But such strains do not last unless watched carefully, and even then they lose their virility after a number of generations—as witness the rose called "American Beauty", which has now disappeared in spite of the great demand for it. I have also been told that the English bulldog is getting rare.[3]

Practically it should not be too difficult to decide whether a given group of organisms is a species or merely a race. The four distinctive criteria of species enumerated in the Conclusion of the last chapter should be amply sufficient for that purpose.

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[3]While Mendel's laws and the new science of genetics help somewhat to understand the mechanics involved in racial changes, their causes are not at all clear. Among plants and animals at least they are rendered possible by the power of *adaptation*, which differentiates them from crude matter; a good deal is due to *environment*, as the new science of ecology has shown. Cf. Murray p. 117.

CHAPTER 11

Number of Species

If it is almost self-evident to the trained mind that there are natural species in the plant and animal worlds, we cannot reach a like degree of assurance on the answer to the next question: *How many* species are there in either kingdom, or how many of them are known?

EARLY ESTIMATES

Aristotle somewhere speaks of 500 species of animals, and Theophrastus, his contemporary, of the same number of plants.

Some pious writers argued to the number of species of fishes from the Gospel of St. John, where we read (21:11): "Simon Peter went up and hauled the net upon the land full of large fishes, one hundred and fifty-three". St. Jerome corroborated the argument by saying that 153 was the number of fishes then given by naturalists. But first of all, St. John speaks only of individual fishes; he says nothing about species; for all we know, those caught in Peter's net may all have belonged to one species or to a few then common in the Sea of Galilee. Second, he speaks only of large fishes; what about minnows, smelt, guppies etc? Lastly, Pliny, a naturalist and contemporary of St. John, gives 144 as the number of species of fishes.

Prior to Locke, some thought that the substantives of ordinary speech expressed each a distinct species, and that therefore the number of species we know is beyond computation. Locke attributed that opinion to the Scholastics. But while it may have been held by some, it was never common doctrine. The fact is that prior to Linné the same animal or plant had different names in different sections of

a country, and often different animals or plants had the same name. Popular names never were and are not today a good criterion of natural species.[1] This assertion is borne out by the story of the American puma as narrated by V. H. Cahalane in the *National Geographic Magazine*, February 1943: "Reading early hunting books or listening to the yarns of old-timers", he says, "one might infer that the Americas were once teeming with wild animals now extinct. Nineteen of these creatures were only one—the puma. Best known today, perhaps, as the mountain lion, he is also called cougar, panther, painter, catamount, brown tiger, varmint, sneak cat, red tiger, silver lion, purple panther, deer killer, Indian devil, mountain devil, mountain demon, mountain screamer, king cat and American lion". No better proof is needed to show that R. S. Lull's definition of species as given in ch. 4 is wide of the mark.

In the 17th and 18th centuries, computations of the number of animal species were a favorite pastime, especially for calculating the dimensions of Noah's Ark and for squaring the data of Genesis with the space required for the animals and their food. Sir Walter Raleigh "thought that there were only eighty-eight distinct species, though he allowed one hundred for good measure. Then he considered their sizes as compared with cows, sheep and wolves, and decided that there would have been seventy-seven large animals and fifty-eight small, equivalent to ninety-nine oxen, eighty sheep and sixty-four wolves. Therefore, the first story of the ark would have furnished plenty of room" (Collier p. 438).[2]

Real naturalists of that period, however, differed widely from Sir Raleigh. "John Ray declared that there were 20,866 species of animals besides 4,500 of fish, and 18,000

[1]Cf. Holman and Robbins p. 16.
[2]"His mathematics is peculiar", adds Miss Collier in a footnote.

of plants" (Collier p. ib.). Linné was more modest in his estimate. He enumerated some 4,000 species of animals in the 10th edition of his "Systema Naturae" (1758). And in the third edition of his "Species Plantarum" (1764) he says: "Numerum plantarum totius orbis longe parciorem esse quam vulgo creditur, satis certo calculo intellexi, utpote qui vix 10,000 attingat".

But by the middle of the 19th century these figures were regarded as far too low. Sir Charles Lyell estimated the number of plant and animal species at more than a million or between one and two millions (II p. 270-2). Others were more conservative. A. Agassiz speaks of "about a quarter of a million species already noticed by naturalists" (p. 5). According to Sir A. E. Shipley (p. 104), a very careful calculation of the number of animal species made in 1881 gave 200,150 species of insects, while the remaining animals amount to only 91,503.

MODERN COMPUTATIONS

If we now ask modern naturalists, their answers differ rather markedly. Let us look at some of the figures, first for both kingdoms together, then for plants, and finally for animals.

1. Speaking very much in round numbers, Sir J. A. Thomson (in The Great Design p. 213) says: "At the very least we must recognize a quarter of a million different kinds of living organisms, each itself and no other. Most naturalists would say half a million, the difference being simply a difference of opinion as to the degree of peculiarity that deserves a particular specific name". In his "Outline of Science" the following figures are given: 200,000 named species of insects, 1000 of bacteria, at least 25,000 named back-boned animals, ten times as many backbone-less animals, and about as many plants.—M. J.

Adler (p. 71) quotes H. S. Pratt as holding that "according to the most recent authoritative estimates, there are 822,765 species of animal, and 233,000 species of plant". The figures given by MacDougall (p. 67) approach these rather closely, so that the over-all number of species would be a little more than a million. But Adler also quotes T. Dobzhanski, who thinks that "a million and a half species of animals and plants combined is a conservative estimate".

2. F. V. Colville, Chief Botanist, U. S. Department of Agriculture, gives the number of plants as 190,900; but "Der grosse Herder" (art. Die Pflanze) puts their number at 400,000. C. J. Hylander (p. 8) allows 250,000 kinds or species of plants. If the numbers given by N. Taylor (p. 323) for various classes of plants are added up, the same figure is reached. Holman and Robbins also say (p. 10): "There exist today upon the earth over a quarter of a million different kinds of plants".

3. Speaking in round numbers, E. Mayr states categorically (p. 275): "There are more than one million species of living animals in existence". Hegner, while admitting in his "College Zoology" that "only about 840,000 species have been described", says in his "Parade of the Animal Kingdom" (p. 1-2): "No one knows how many kinds or species of animals are now living on the earth, but three million is a conservative estimate". Others, however, are less generous. D. M. S. Watson states (Encycl. Brit. s.v. Zoology) that "the number of animals, both living and extinct, which has been investigated, is very great, perhaps approaching two million separate forms". But, according to a *N. Y. Times* editorial of March 19, 1939, British scholars are now preparing a complete zoological index containing 250,000 names, which would classify all known animals and bring Linné's work up to date, at least to 1935. According to W. C. Allee (in Newman's The Nature etc., p. 261), "there

are some 600,000 recorded species of living invertebrates and 35,000 known species of vertebrates".

Going more into detail, N. Fasten (p. 89-95) enumerates 16 phyla of animals and gives the number of species each contains. By far the most numerous are the Arthropoda with 650,000 species; next come the Mollusca with 80,000, then the Chordata with 65,000 and the Protozoa with 15,000 species. Sir A. E. Shipley wrote in 1923 (p. 104): "I have recently had occasion to consult the authorities of the British Museum as to the number of known species. They estimate that mammals number 10,000, birds 16,000, reptiles and amphibia 9,000, fish 20,000, mollusca 60,000, crustacea 12,000—probably an underestimate—whilst the number of insects is now put at 470,000, a little under half a million". Further on (p. 154) he says: "In number of species they (insects) surpass all other terrestrial animals; compared with the vertebrata their number is colossal". Cl. Wood enumerates the following "described species": 450,000 of insects, 60,000 of hymenoptera, 80,000 of lepidoptera, 180,000 of beetles. Lee A. Strong, of the U. S. Department of Agriculture, states rather categorically: "There are known more than 700,000 kinds of described and named insects in the world" (1937 Report of the Smiths. Inst. p. 377). Webster's New International Dictionary, however, says (s.v. Insecta): "According to a conservative estimate it (the class Insecta) comprises at least 10,000,000 species, of which 465,000 are known to science".[3]

E. Mayr now comes and throws doubt on all these figures, claiming that they are comparatively old, that tens and hundreds of new species of animals have been discovered recently, even in places which were supposed to have been thoroughly raked over (p. 5-6).

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[3]Is 10,000,000 perhaps a misprint for 1,000,000?

ATTITUDE OF SCHOLASTICS

1. The Scholastics are, as a rule, vague and non-committal. Shallo (p. 264) proves that horses and dogs are species: "The various races and breeds of horses are like each other in fundamental structure and function; they differ essentially in structure and function from other groups of animals, e.g. dogs; and finally, the union of individuals of these races and breeds with one another is capable of perpetuating itself". Lahr (I p. 620) thinks that we know at least some species of plants and animals; but he gives neither examples nor numbers. de Backer (I p. 230) closes his discussion of the definition of species with the remark that some (plures) species are admitted by everyone, and that we therefore need not worry overmuch about the lack of a precise definition; but he does not tell us which are those species admitted universally. Urráburu (I p. 493) is convinced that we are sure of very many (plurimae) species; but he, too, fails to specify. Donat (Cosmol. p. 385) says: "Numerus specierum plantarum et animalium tum fossilium exstinctorum tum recentium immensus est".

Only a few Scholastics are more definite. T. Pesch, evidently echoing the pronouncements of the zoologists of his time, gives the number of "classes" of animals, in the first edition (1880) of his Instit. Phil. nat. (II n. 588-9), as 150,000, in the second (1897) as 250,000. P. Schanz, writing about the same time (1895), says (I p. 188): "The number of animal species is today estimated at 320,000, that of plant species at 500,000 phanerogams and 20,000 cryptogams". Willems (II p. 209, 211, 213, 217) several times distinguishes between natural and systematic species, and once asserts that there are about 700,000 species (presumably natural) of plants and animals. The same figure is given by J. Schwertschlager (II p. 192), who adds 100,000

fossils. Urráburu (I p. 490) creates himself unnecessary difficulties by supposing that hybrids are new species (infra p. 115).

2. Catholic Neo-Lamarckians (Wasmann etc.) admit only a few natural species, viz. those which have a distinct "structural type" and which God created in the beginning. These few are supposed to have then naturally evolved into the thousands or millions of systematic species of modern natural history. We shall say more about this theory in chapter 23.

3. M. J. Adler, who is not a Catholic, but claims to be a Thomist, says more than once that there are natural species; yet he thinks that the number of those we know for sure, is very small, and he mentions only four: brute, plant, mixture and element (p. 58-9, 128-133, 217). Which is tantamount to saying that there are none in the accepted sense of the word or that we know none, or else that there is no difference between genus and species.

Adler also argues (p. 268) that "neo-scholastics who think that there are many natural species within the domains of plant and brute, cannot avoid either denying scientific evidence or evading its implications somehow". The last part of the sentence is somewhat cryptic (as so many of Adler's statements); but he seems to mean what he says more clearly on the next page, viz. that the "philosopher while confessing his dependence on the scientist for knowledge of distinctions below plant and brute, transgresses the sphere of his competence,—violating the autonomy of science,—by deciding what scientific evidence he will accept or reject".

An untenable position. After all, the philosopher is not wholly dependent on the scientists for knowledge of divisions within the realm of life; everyday experience forces some of them on him. Moreover, the autonomy of science must not be exaggerated; if we proclaim its total independence, we have again the theory of the double truth,

which St. Thomas buried once for all seven centuries ago. And if we are to accept scientific pronouncements sight unseen, we might as well call ourselves agnostics, since many of their pronouncements smack of agnosticism.

Rather a distinction is to be made between the various statements of the scientists, and their theories are to be tested by higher notions and principles. This is the philosopher's share of the problem of species.

CONCLUSION

What then shall we say about the number of species, past and present?

Certainly, the diversity in the figures put down by naturalists is tantalizing, all the more so because the layman has no means of controlling or revising them. We must also remember that the class names (of which "species" is one) have not always remained the same, and that there is great uncertainty today as to what exactly is meant by a species. Lastly, one can readily subscribe to what Charles R. Knight says in the *National Geographic Magazine,* Febr. 1942: "We shall never know more than a fraction of the thousands of types of animal life which have peopled this world through its long and ever-changing history" (p. 142).

But the number of natural species in both kingdoms is undoubtedly *very great* (immensus, as Donat says), and perhaps, if we abstract from fossils and so far as present-day knowledge goes, not too far from the average given by *modern naturalists.* This conclusion is borne out by the fact that they use a combination of criteria before they pronounce a group of organisms a distinct species, and that many of the species described in books on botany and zoology have all the earmarks of natural species.

But our discussion can proceed without a knowledge of the exact or even approximate number of species in the two kingdoms of life.

CHAPTER 12

Origin of Species

This chapter harks back to the third, where the origin of life in general and of its three grand divisions was discussed. In chapters 8-11 we saw that the two kingdoms below man are broken up into many species, hundreds of thousands of them, perhaps millions. The fact stands, although exact or even approximate figures are not available.

The question to be discussed now is: Whence are all these separate species? What is their origin?

I shall do no more than recall to the reader Lucretius' poetic account of creation in the fifth book of "De Rerum Natura", and Milton's famous description of the origin of animals in the seventh book of "Paradise Lost". They are poetic fancies and must be interpreted as such. Humboldt thought that the origin of species was one of those mysteries which it was not given to natural science to penetrate. Perhaps so. But there are other methods than those with which natural science works. Nor need we, to find the answer, fare forth and travel all the way to South America as did Wallace and Bates. Clear, logical thinking can also solve problems, and that can be done at home in one's study, provided it is equipped with the necessary literature.

We shall first give the positive answer to our problem, but so as to separate the paramount issue from irrelevant problems which are often mingled with it. Then we shall deal with the only other alternative, the theory of evolution, which also claims to explain the origin of plant and animal species. Finally, we shall study the attitude of Catholics to the theory of evolution.

1. CREATION

1. We maintain that what holds for life in general and for each of its grand divisions, also holds for each natural (not systematic) species. *God stands at its beginning.* For the plant and animal kingdoms exist only in their species; they are nothing more than an aggregate of their natural species. God stands at the beginning of the two kingdoms inasmuch as He stands at the beginning of the natural species into which they are divided.

For reasons to be discussed further on in this chapter (p. 101), we do not appeal to Scripture. But the argument from reason and experience is peremptory. No species of plant or animal has always existed, and the first criterion of natural species, indefinite fertility, or rather its negative side, mutual sterility, assures us that natural species do not spring from one another. We saw the obstacles which nature has put in the way of undesired cross-fertilization; occasional hybrids are condemned to sterility. Also, the definite number of chromosomes, the life-cycle and its pre-determined stages, specific animal instincts cannot be inherited from organisms which have them not; nemo dat quod non habet. Briefly, each species is *something new,* not contained in any other species. If then the principle of causality holds, a preternatural cause is demanded to account for the origin of each species. God had to intervene directly, and Linné was right when he said: Species tot sunt quot diversas formas ab initio produxit Infinitum Ens; or as he worded it elsewhere: Species tot numeramus quot diversae formae in principio sunt creatae.

2. The Catholic Church has never taken a definite stand on the origin of plant and animal species. Hence some Catholic scholars, unimpressed by the philosophical argument and dazzled by the wide popularity of the theory of

evolution, have accumulated objections against creation as the origin of natural species.

In the Dict. apol. (s.v. Transformisme col. 1804-7), de Sinéty and Teilhard de Chardin argue that immediate creation would make the origin of species *mysterious* and *inconceivable*. They would substitute for it "epigenetic evolution".

But they have to admit themselves that the origin of species remains a mystery no matter what theory is adopted. So why not leave the mystery where it fits into the picture? And when they speak of immediate creation as inconceivable, they really mean unimaginable. And that we concede. We really do not know the concrete circumstances of the first origin of a single natural species. But again, do we know the concrete circumstances of epigenetic evolution which they favor? Then, too, what about the beginning of life in general, which both ascribe to divine intervention (ib. col. 1819-1822)? Is it not something mysterious and unimaginable? Lastly, both admit that we have no evidence for any transition from one phylum to another, from one class to another, from one order to another (ib. col. 1818-9). How then did phyla and classes and orders originate if not by divine intervention? And if these could originate in such preternatural fashion, why not also species?

de Sinéty further argues that immediate creation of species would be *against God's wisdom* and so against His potentia ordinata. But to prove it, he has recourse to ridiculous hypotheses as to the concrete circumstances of creation. A Scholastic therefore would throw his case out of court by saying: Nego suppositum. Harking back to Lamarck (infra p. 99), Prof. Dwight puts the same argument better (p. 59): "It seems more in accordance with our poor ideas of Creative Wisdom to have species develop according to a general law than through an indefinite series

of acts of special creation". We shall see later (infra p. 225, 235) that Prof. Dwight here glimpsed a beautiful truth concerning plant and animal species. But it needs to be moved into the right focus, since a posteriori arguments show conclusively that God did not proceed in the exact fashion that the Professor envisages.

Donat (Cosmol. p. 385), Schwertschlager (II p. 211), Agar (p. 88) etc. argue that God does not do Himself what can be done by natural causes. No Catholic, especially no Scholastic, will controvert this one premise. But what requires proof is the second premise, viz. that natural causes are able to initiate new species. Experience is dead against it.

Agar (p. 90) advances this curious argument in favor of evolution: "Many able minds which have investigated this problem have been led to conclude that evolution is true, and it is not consonant with our ideas of God to suppose that He would construct nature so as to give us a totally erroneous idea of its workings". How many pseudo-scientific fancies could be proved true with this as a premise. Just think how many "able minds" held the motion of the sun around the earth, spontaneous generation etc.

Donat (Cosmol. p. 360-1) also appeals to what we have called *functional* and *ontogenetical* differences to show the expansive mood of nature. This is a sophism, a transitus ad aliud genus. The two differences are precisely infra-species, and there is no sign whatever that nature tends to widen them, to enlarge them into specific differences.[1]

3. So far we have dealt with the prime issue in this whole question, and the answer must be convincing to anyone who can follow a strictly scientific-philosophical argument. But there are a number of problems connected with it which may be freely disputed and for which we shall

[1]Cf. Monaco p. 233-5.

probably never find a definite solution, but which for that very reason are sometimes dragged in to confuse the main issue.

a. One problem is this: How did God create the first ancestors of each species? Was it creation in the strict sense of the word? For example, did God create the first chicken (or the first egg, if you will) *out of nothing*? Or did He *vivify* matter already existing, as biologists have tried to do unsuccessfully? Or (in accordance with Lamarck's conception) did He infuse into matter the (active or passive) *power* to develop into the various species as external conditions for them would be ripe?

All three modes were undoubtedly possible, and none of them would conflict with our main thesis.[2] But our question is: Which of these modes did God *actually* choose to begin each species? The question is one of historical fact, not of possibility.

E. C. Messenger contends (p. 16, 274) that the third mode is the only rational one, that it is definitely taught in Genesis "according to its plain and obvious sense", and that this was "the unanimous interpretation of this Scriptural statement by Fathers and Theologians up to the thirteenth century". He follows in this Canon Dorlodot, whose book he translated into English.

But first of all, as was pointed out in chapter 3, the term "unanimous interpretation of the Fathers and Theologians" has a very definite meaning in Catholic circles and should not be employed loosely in a supposedly theological discussion. Secondly, while Catholic exegetes incline to the view that, according to Genesis, the origin of plants and animals came about in the second mode, they say that none of the three modes is taught definitely or even insinuated

[2]Cf. Monaco p. 190-200.

by Moses. Hence Catholics are free to adopt any one of them, which they would not be if Fathers and Theologians for 13 centuries were agreed on the interpretation of the relevant passages of Genesis.[3]

b. Supposing that God initiated new species by vivifying matter already existing (the second mode), Scholastics further asked themselves what *kind* of matter God chose for that purpose. One who is interested in this question, may consult Suarez, De opere sex dierum II cap. 10 n. 13 sqq.[4]

c. Another question concerning the origin of species, no matter which mode was chosen, is this: *When* did God create the various species? Did He create them all simultaneously or successively? And if successively, which were first, second, third and so on? Also, how much time elapsed between the origin of the different species?

As is well known, St. Augustine favored the simultaneous creation of all species at least in germ, and Linné's two dicta seem to reflect the same idea (ab initio, in principio). Modern Catholic exegetes and theologians leave the answer to paleontology. And paleontology assures us that not all species of plants and animals appeared at the same time, though some of both existed as early as the Cambrian period, from which date the first undoubted fossils.[5]

d. Suarez (De opere sex dierum II cap. 7 n. 8; ib. cap. 10 n. 5) also discusses the place or *region* where the single species were originally created. He thinks that not all were produced everywhere, but that God distributed them over different regions.[6]

e. The last question is of little importance: Did God create originally only one individual (where reproduction

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[3]Cf. Dict. de la Bible, Suppl. s.v. Génèse col. 603.
[4]Cf. Urráburu I p. 581; Beraza p. 500; Palmieri p. 155-6.
[5]Cf. Chr. Pesch III n. 92; Urráburu I p. 581-5; Beraza p. 500; Palmieri p. 144-5, 151-5.
[6]Cf. Urráburu I p. 585; Beraza p. 500.

is asexual) or pair—or did He create at once *many* (individuals or pairs) of each species, perhaps scattered through large tracts and distant regions? Both modes were, of course, possible; but most likely we shall never know. Beraza surmises that on this question "nihil prorsus definire possumus".[7]

But it seems that an answer can be given to the question, often put humorously, which came first, the egg or the chicken. For if God is the author of each species, He must have made the first organisms in such a state that they could live without extraordinary help on His part. That means that the first specimens of many animal species were created in the *adult* stage, since earlier stages in the life-cycle demand the care of parents, without which the young must perish. But whether this argument holds for all animals and also for plants, is far less evident. Beraza thinks it more probable that God planted the seeds of vegetables in the soil and then left their development to natural causes.

2. EVOLUTION

1. The theory of evolution is of recent date. With the possible exception of Anaximander, none of the ancient philosophers can rightly be put down as its forerunner. Neither Plato nor Aristotle ever faced the problem of the origin of species; neither seems to have doubted their essential fixity.[8] Nor was it the purpose of those who first proposed the theory, to get rid of the Creator. Lamarck, the grandfather of the theory, saw in evolution the unfolding of a great divine plan. But in the hands of Spencer, Huxley, Haeckel etc. the theory became one of the most

[7]Cf. Urráburu I p. 586; Collier p. 428-9.
[8]Cf. More p. 121-8; de Sinéty, in Dict. apol. s.v. Transformisme col. 1796.

serviceable tools for undermining all faith and religion. Evolution has become the opium of modern unbelief.

The theory is proposed in *two forms*. One, the more popular form, conceives evolution to consist in a simple change from one species to another. The scientific theory of evolution holds that all species now existing evolved from one original organism (monophyletic evolution) or from a few simple organisms (polyphyletic evolution), becoming ever more complex and differentiated in the process.

Darwin held the popular form of evolution, accepting it as a "dogma of science"; he accounted for it by minute chance variations and natural selection, resulting in the survival of the fittest. But today the strongest argument for it is taken from *mutations,* first proposed by Hugo de Vries, a Dutch botanist. Mutations, as distinct from ordinary variations and modifications, are discontinuous changes unconnected with the type of species from which they sprang. Examples are the evening primrose, the Shirley poppy, the Ancon sheep etc.[9] Darwin knew of mutations, but dismissed them as of little significance; de Vries saw in them "species in the making"; so did Thomas Hunt Morgan, American zoologist, who performed thousands of experiments with the Drosophila melanogaster. B. C. Gruenberg writes (p. 276): "The facts of mutation so far observed and the facts of heredity determined experimentally give us unmistakable assurance that the transmutation of species is in accord with the nature of living things". By the "facts of heredity determined experimentally" Gruenberg means Mendel's laws.

2. The theory has been under fire for many years and from various angles. Reserving discussion of the scientific

[9]Cf. C. S. Gager, in "The Great Design" p. 181-2; de Sinéty, in Dict. apol. s.v. Transformisme col. 1818.

form for chapter 23, let me say the following concerning its popular form.

a. The problem of evolution, at least as regards the mutability of species within the plant and animal kingdom, cannot be settled by an appeal to *Scripture*. Where the term "species" (min) occurs there, for instance in the first chapter of Genesis, it is not used in our scientific and philosophical sense. Catholic exegetes are agreed today that it there has or may have the loose meaning of popular usage, or rather of the usage common at the time when Genesis was written. And that usage, like today's, was neither scientific nor philosophical, but was formed "sicut communis sermo per ea ferebat tempora", as Leo XIII put it in his encyclical "Providentissimus Deus" (1893), and as the Biblical Commission repeated it later (1909). Writing in 1934, Fr. Ceuppens notes to Genesis 1:11: "Notandum est non esse necessarium heic genus vel speciem in sensu stricte scientifico intelligere".[10] St. Augustine's dictum applies here as in so many other passages of the Bible, that God did not give us the sacred books to teach us the way of the heavens (i.e. astronomy), but the way to heaven. Which is not the same as saying that the respective passages are not inspired or true, but that their author had no intention of writing a scientific or philosophical textbook.[11]

On this point I therefore differ from Fr. Urráburu (p. 524-539), who fails to distinguish between the various connotations which the term "species" may bear. On the other hand, there is no reason for suspecting that mere varieties may be included in the Scriptural term for "species"; the exegetical difficulty is that no distinction is made between genera and species, as St. Thomas realized.

[10] Cf. Heinisch p. 106.

[11] Cf. de Sinéty, in Dict. apol. s.v. Transformisme col. 1793-4; Boyer p. 102. More on this principle of Scripture exegesis in Cotter, Theologia Fundamentalis p. 603, 648-650.

b. But we do not need to appeal to Scripture. The criteria of species rule out any transmutation of species. If evolution were the driving power within the two kingdoms of life, the criteria should be the exact opposite of what they are. Nature should favor hybrids and do all in her power to perpetuate them; gaps between natural species should show signs of closing; the number of chromosomes should fluctuate like the stockmarket in a financial crisis; the various stages of the life-cycle should become blurred and lose their periodicity; dogs should learn to hunt mice or cats should begin to bark at burglars—whichever species is thought to be higher in the scale of life.

Many evolutionists admit that evolution is against the present biological laws. But if that is so, then Lamarck and Darwin were wrong when they tried to base their theory on the present-day flora and fauna.

Still, could it not be that evolution is not a law of nature now though it was in the geological past? Perhaps. But then the laws of nature have changed, and how are we going to argue from the present to the past or vice versa, as we must and as evolutionists constantly do? Since Lyell's time certainly, geology proceeds on the supposition that the physical and chemical actions of today are the guides in estimating all previous ages. Can we judge otherwise of biological functions? Furthermore, when we reflect on the narrow limits within which the living organisms are changeable today, it sounds a priori improbable that God should have chosen radical changes of almost unlimited extent for building up the domain of life.[12]

c. P. M. Périer, who wrote extensively on evolution, says in his book "Le Transformisme" (p. 51): "La variabilité des espèces paraît un *fait dûment constaté*", and then goes

[12]Cf. T. Pesch, Welträtsel II p. 213-7; More p. 148; Gruenberg p. 295-7; Murray p. 351-2; W. A. Hauber, in EcclR 1942 I p. 166-9.

on to inquire into the causes and the mechanism of evolution. Yet the facts on the strength of which this judgment is pronounced, are scarcer than white mice. Or rather we may say that facts quoted in its favor are plentiful, but that their interpretation in its favor is merely a case of wishful thinking. Darwin himself admitted that not a single case of a change of species had yet been proved. The fact is that evolutionists look for an explanation before they are sure that one is needed. Instead of first proving to the hilt the reality of change of species, they constantly suppose it and labor hard to discover its conditions and mechanism. Both Lamarck and Darwin hit upon this unnatural theory because they shut their eyes to the distinction between species and varieties, which can now and could then be made by means of good criteria.

Perhaps the strongest argument is the one from *mutations*. But the basis of facts is rather slender for a general theory as wide as evolution. Hans Driesch wrote not so long ago in "The Great Design" (p. 290): "What we know about discontinuous variation, called "mutation", is, as yet, very scanty". Not only that, but the only criterion by which mutations are approximated to new species, is that of the marked gap. But we saw how precarious that criterion is when taken by itself. Moreover, how do mutations differ from sports and freaks such as tailless kittens, white blackbirds, weeping ash, thornless roses, stoneless plums etc.? These certainly are not new species nor even species in the making. Lastly, the variability of de Vries' Oenothera may be a case of Mendelian segregation. The original plant was a hybrid embodying characters from many varieties; these characters, hidden in the mother, suddenly re-appeared in the daughter plants. Nor did Morgan, with all his experiments, succeed in producing something really new (e.g. a

new organ), and almost every one of the variations was a distinct disadvantage to the poor Drosophila.[13]

Also, equating change of species with Mendel's laws is a sophism, an illogical transitus ad aliud genus; for Mendel's laws are valid only for infra-species variations.[14]

d. In any case, Darwin was wrong when he tried to account for evolution by the addition of minute changes. That part of his theory is not only impractical, as has often been pointed out, but also hopelessly unphilosophical. Specific changes, if they ever take place, must be instantaneous and total. Each new plant and each new animal demands a *new soul,* and no soul can exist in a body which is not completely attuned to it. The soul of a gorilla could not exist in the body of a gibbon which still has the blood, cells, tissues, bones etc. of a gibbon; the new animal would sicken and die. Not long after the discovery of the circulation of blood, experimenters piped sheep's blood into human beings, but inordinately frequent deaths among the patients discouraged the practice. Later it was discovered that even the wrong type of human blood, far from helping the patient, brought on convulsions. It all goes to show how dependent the soul is on the proper constitution of the body.

e. A change of species would of course be a substantial change. Now Scholastics, analyzing the notion of substantial change, came to the conclusion that it demands *privation* as a third principle besides matter and form. There must be something lacking and a tendency to supply what is lacking.[15] But whence such a privation in a healthy gorilla or gibbon? Scholastics further argued that for a species to tend to become another, would be a tendency to commit sui-

[13]Cf. Marcozzi l.c. p. 427-9.

[14]For the same reason, the eight "macroevolutionary factors" on which E. Mayr relies (p. 292-3), are of no avail. Cf. O'Toole p. 16-30.

[15]Cf. Maquart p. 527-8.

cide, whereas all beings have a natural tendency or desire to preserve their identity. As St. Thomas put it (Summa theol. I qu. 63 a. 3): "Inest unicuique naturale desiderium ad conservandum suum esse, quod non conservaretur si transmutaretur in alteram naturam".

3. CATHOLICS AND EVOLUTION

Catholics, as a rule, are unfavorably disposed toward the theory of evolution. St. Augustine is sometimes quoted as favoring it.[16] But this is a misinterpretation of his thought. True it is that, owing to some Scripture texts, he thought that all living species were contained in germ (in semine, in virtute, in potentia) in lifeless matter since the day of creation. But he never dreamt of saying that one species could change into another.[17] St. Thomas more or less agreed with St. Augustine's idea, but restricted it to those animals which are generated "ex corruptione animalium" (Summa theol. I qu. 69 a. 2; qu. 71 and 72; qu. 73 a. 1 ad 3); he may be excused because he had to face the supposed fact that worms and maggots arise through spontaneous generation. In spite of its extrinsic authority, St. Augustine's idea was rejected by Suarez (De opere sex dierum II cap. 7 n. 3); he saw in it an unnecessary multiplication of miracles, and "opera miraculosa vel extraordinaria absque necessitate vel sufficienti testimonio audienda non sunt".[18]

At the opposite pole stands the American botanist Edward Lee Greene, who, to avoid every taint of evolution, raised every variety of plants to the dignity of a species, allowing no post-natal influence of soil, climate or environment. That was fixism with a vengeance.[19]

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[16] Cf. Dorlodot p. 80-7.
[17] Cf. O'Toole p. 74-5; Beraza p. 497-9; Boyer p. 110.
[18] Cf. Klubertanz, in *The Modern Schoolman* Nov. 1941 p. 11-14; Maquart p. 516-8; Boyer p. 105-112, 115-120.
[19] Cf. *The Catholic World*, Febr. 1945 p. 444-9.

Today, not a few Catholics grant the theory of evolution —within limits—some degree of probability. It was not easy to dissociate the biological theory from its wholly unauthorized extension to ethics, sociology and religion, contained in the vagaries of Spencer, Huxley and Haeckel. But once the theory was brought back to its legitimate place in biology, once it was seen that biological evolution, if rightly understood, would not dim but enhance the glory of the Creator, Catholics were inclined to look with less apprehension on this enfant terrible of the 19th century. And there arose some Catholic Lamarckians, whose viewpoint is thus expressed in Apologétique (p. 888): "Peut-être y a-t-il même dans cette idée moderne d'évolution une vue de monde plus grandiose, un sens de l'unité et de la grandeur de la vie qui font mieux deviner la personnalité de l'auteur du monde et de la vie".[20]

We shall say more about Catholic Lamarckians in chapter 23, but must still mention those few Catholics who think they can accept evolution by denying that the plant and animal kingdoms are broken up into natural species. This, as we saw, is really Adler's position. But John X. Pyne likewise says (p. 9): "Philosophically speaking, there would be no transition from species to species if one form of plant life were to develop into another form of plant life, or if one form of brute life were to develop into another form of brute life".[21] But such an attempt to reconcile evolution with scholastic philosophy is doomed to failure, because both everyday and scientific experience assures us of the existence of natural species within both kingdoms of life.

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[20]Cf. Dwight p. 52-3; Dorlodot p. 42; Agar p. 58-61.
[21]Cf. Schmid p. 72-4.

CHAPTER 13

Species and the Individual

This chapter is not really necessary for the progress of our thought, since our main business is the definition of species. Still, only individuals exist in nature, and therefore a few words on the individual and its relation to the species will not be deemed altogether out of place.

We shall confine ourselves to three questions: *What* is an individual? Which are *nature's individuals?* What is the *relation* between species and individual?

1. NATURE OF THE INDIVIDUAL

1. Let us begin by distinguishing *natural* from artificial individuals. An individual in the proper sense of the word is one which occurs naturally (e.g. John Doe) ; an artificial individual (e.g. a chair) is an individual only in an improper and derived sense. There is some similarity between them, but there is also an essential dissimilarity, which must not be ignored. Therefore one should be cautious in applying to one what is true of the other.[1]

2. Scholastics *define* the natural individual as a substance, complete and undivided in itself, but divided from every other substance.

To explain. An individual is first of all a *substance;* it stands on its own feet, as it were, unlike the (ontological) accident which must inhere in something else. Accidents may be parts of an individual; they are not individuals. Then the individual is a *complete* substance, inasmuch as it has whatever is necessary for the thing to exist; it thus differs from an incomplete substance, which can only exist as the

[1]There are also moral and legal individuals or persons; but we can disregard them in our discussion.

complement of another substance. Furthermore, an individual has *unity*, the first of the transcendental attributes of being; it is either simple, or its parts are so united as to form one being. Lastly, being *divided* from every other substance, the individual is by itself.

Corporeal substances, with which this essay is alone concerned, consist, according to the common scholastic doctrine, of two incomplete substances, two substantial parts (matter and form) and many integral parts (e.g. hands and feet). Nevertheless, they are true individuals if their parts belong together by nature, and if they are separated from other corporeal substances in time or place or both.

3. To forestall possible misunderstandings, we must dilate a little on each of the three adjectives by which "substance" is modified in the general definition of the individual.

a. An individual is a *complete* substance. Now *functional differences* present a difficulty rarely discussed. How can either man or woman be called a complete substance since both are naturally incomplete in a vital function? For, neither without the other is capable of reproducing one of the same kind.

The answer is that scholastic definitions were not made in a vacuum. The term "complete" in the definition must not be conceived independently of experience, and experience assures us that such completeness is not necessary. Why human beings do not come into the world like Athena who sprang from the head of Zeus, why nature willed sexual reproduction for mankind, why no human individual has by itself the adequate power of producing offspring—I leave to wiser heads.[2]

[2]Cf. Donat, Cosmol. p. 200-1; Lavaud, in *The Thomist* 1940 p. 459-518.

b. An individual must have *unity*.

At the outset, we reject the idea of some biologists who would make of every cell in the organism an individual, and who would therefore degrade the organism to a colony of individuals.[3] The integral parts of an individual are not individuals; my five fingers, for instance, are not individuals; they are parts; they exist only as parts, and except as parts, they have no meaning, they are nothing.

The same principle holds for matter and form taken separately, for faculties, powers, more or less localized qualities, chromosomes, hormones and genes. These are not nature's ultimate units, no matter how much scientists may hypostatize or even personify them. They are essentially parts, and nature meant them for parts. And while the scientist may, for the sake of more detailed knowledge, confine his studies to them, the philosopher is bound to take a wider view. He must look on them as primarily parts, because, that being their true nature, they cannot be fully understood except as parts.

Secondly, the individual is *prior* to its parts.

Unlike the prairie town, which grows up from a juxtaposition of homesteads, in nature the whole is primary, the part secondary. Nature intends the whole, the individual; integral parts might almost be called adjuncts. As embryology tells us, the organism does not originate by the mere juxtaposition of cell to cell, of tissue to tissue, of organ to organ. The individual, one cell to begin with, grows by creating for itself cells and tissues and organs as and when needed. Hence, if we wish to be accurate, we must say: Integral parts, even if all be taken together, are not the individual; the individual has them.

Thirdly, corporeal substances, being individuals and yet

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[3]Cf. More p. 277-285; de Backer I p. 61.

consisting of many parts, need a *unifying principle.* Every corporeal individual, down to the minutest microbe or virus, is a complex structure, consisting of many heterogeneous parts, each of which has its own laws and the tendency to follow them blindly. But in the healthy organism these laws are all subordinated to a higher law, the law of the whole. What is this that imposes its law on all the parts of the individual? It must be something real; for the higher law is something real, and the unity of the individual is real. It cannot be any of its parts; it cannot be matter, something sensible like the hoop of a barrel. It must be something substantial; for the result is a substance. It must be a substantial, yet suprasensible principle like the *form* of which Scholastics speak, and which is called *vital principle* or *soul* in living organisms. Nothing else will do; nothing else will account for the facts of life. Certainly not that unknowable bond or organization which the modern theory of "creative synthesis" wishes to substitute.[4] After all, the unity of an organism is precisely its organization, and so instead of giving us the cause, this theory offers us a synonym of the effect.

c. Being *by itself*, every individual is to some extent independent. But this independence must not be exaggerated. Individuals do not and cannot exist in a vacuum. No individual in this material world exists absolutely by itself; all act on others and react to their influence.

We shall enlarge on this important truth in ch. 15 and 16.

2. NATURE'S INDIVIDUALS

After this highly metaphysical introduction, let us pass on to an easier and more interesting question: *Which* or *where* are nature's individuals?

[4]Cf. Fasten p. 28-9.

1. The answer is easy enough in the case of *man*. Each human being, every man, woman and child is an individual, nay a person. Nor is there any practical difficulty of telling human individuals apart. Not only do they exist separated in time or place or both, but each human being is intimately conscious of his or her own Ego, which is perceived in and with all conscious activity. This latter test can also be applied to Siamese twins, who are undoubtedly aware of the difference of personality.[5] It cannot be applied to the human foetus or embryo; but though this is still connected with the mother, it is destined by nature for an independent life.

Psychiatrists relate cases of "double personality", where a human being feels like being two persons, a sort of Doctor Jekyll and Mr. Hyde. Yet they also tell us that the one so afflicted is vaguely conscious that he is, in the last analysis, one, not two. In any case, we have a perfect analogy with billions of other human beings, and just as they are individuals, so those who—per accidens—suffer from double personality.

2. Each *animal*, too, is an individual; so is each *plant*. Of course, they are not persons. Unlike man, they are not their own masters; they are the slaves of their specific activity; they pertain more to the species than to themselves; the species lords it over them to such an extent that they may be said to exist only for the species.

As a rule, too, it is easy to distinguish individuals in the two kingdoms. Still, doubts may arise in some cases. The facts are well known to naturalists, but they also have an interest for the philosopher.

a. What are we to say of so-called *compound animals*, such as corals? Not only do they bud from a common stem

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[5]Cf. *Reader's Digest*, Sept. 1943 p. 67-70.

and remain joined to it for life, but different components exercise different vital functions: some do the eating, others the digesting, others again take care of defence etc. Where then is the individual? Sir A. E. Shipley (p. 20) thinks this "a problem which is very difficult to answer", and suggests that "the whole colony must be looked on as an individual". Also Webster (s.v. Individual) pronounces the question "difficult to decide".

Still, such animals might be compared to Siamese twins, in some of whom similar phenomena have been observed. There is, however, one big difference. In compound animals this condition is per se, whereas in human beings it is clearly per accidens. Nevertheless, as in Siamese twins, each coral would be an individual, not merely the whole stock.

b. A difficulty not altogether dissimilar is met with in *colonies* of animals, such as bees, wasps, ants and their guests etc. While the single animals (or rather classes of them) perform different functions necessary for the household, they differ from compound animals in not being joined by a visible bond.

But what was said about functional differences, applies here mutatis mutandis. It seems that some or all of the vital functions are divisible, so that parts of them may be distributed among different individuals. An essential imperfection, which is absent from spiritual beings.

c. Then there are cases where *parts of an individual* develop into new individuals. Thus a worm may be cut into pieces, and each piece, unless too small, will grow into an entire worm of the same species. The same is true of many sponges. Any one of the arms of a starfish, if cut off with part of the disc, will regenerate an entire body.[6] The phenomenon is very common in plant life. Leaves of begonia,

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[6]Cf. Chidester p. 68.

when cut off and stuck in the soil, take root and grow to be new plants with flower and fruit. In some plants (and some animals), spores separate from the parent body and become new individuals.

The philosophical difficulty here is neither at the beginning nor at the end of the process. A part of the individual becomes a whole individual. But what is to be said of the intervening stages? They seem to be neither parts nor wholes. What then are they? The best answer seems to be that of the Scholastics, who say that they are individuals in fieri, incipient individuals, on-the-way individuals. The original plant or animal was one individual actually, many potentially. An imperfect degree of organic unity.[7]

d. A difficulty of another kind is presented by some plants, such as fern, sedge, strawberry, portulaca, which, pushing forward under the soil, *grow in front* and decay behind. The special difficulty here is this: Since such a plant never dies wholly, must we say that each individual is immortal? Or can we say that each season's growth represents a new individual?

Analogy would seem to favor the latter view. The new fronds may be likened to the spores which serve reproduction in some plants, though, unlike spores, they do not at once separate from the parent stem. Which implies that the last element of the definition of the individual, viz. division from all other beings, is not as perfect in these lower realms of life as e.g. in man.

3. The problem of the individual becomes acute as we enter the realm of *inorganic* nature; rocks, metals, gases, liquids etc. Sub-atomic physics has accentuated the difficulty. Where are nature's ultimate units here? Are they the

[7]On the further question as to what *kind of life* such incipient individuals have, cf. de Sinéty, in Dict. apol. s.v. Transformisme col. 1833-4; Monaco p. 88-94, 98-102, 130-5.

electrons? Or perhaps the protons? Or something yet smaller? The doubt has even been proposed: Are there any individuals at all—or is inorganic nature just a nondescript mass, that "rudis indigestaque moles" which Ovid placed at the beginning of things?

But as we are only dealing with organisms, we may transmit this problem.[8]

3. THE INDIVIDUAL AND ITS SPECIES

Three questions call for a brief discussion here: a) Must every individual belong to a species? b) Can one and the same individual belong to two species? c) In what is called a specific or substantial change, does the individual remain the same? However, from the philosophical standpoint a further question is of even greater importance: d) In what sense can species be said to exist?

1. The first question is easy of solution. Nature knows nothing of halves. If nature is allowed to take its course, all nature's individuals are wholes, that is, they have the complete essence of a species. Functional incompleteness within the species does not contradict this law. Hence the Scholastics called the specific essence *indivisible,* meaning that every individual has the whole of it or it cannot exist.

If we therefore draw the technical distinction between genus and species, we must say that belonging to a genus without belonging to a species is impossible. The genus is something essentially incomplete demanding as its complement a specific difference. A purely generic being of any kind would be a metaphysical monster.

Hybrids, of course, are individuals. But to what species do they belong? To that of the father or of the mother? Or do they perhaps constitute species of their own? St.

[8]Cf. Cotter, *Cosmologia* p. 29; Saintonge p. 430-9; J. G. Moran p. 371-4.

Thomas (Summa theol. I qu. 73 a. 1 ad 3) and Urráburu (I p. 490) suppose the latter. Schiffini (I n. 161) subtly argues from Aristotle that they belong to the species of the male progenitor.

Now there are hybrids and hybrids. In a loose sense, a hybrid (mongrel, half-breed, cross-breed) is a cross between infra-species varieties of the same species; but they certainly do not constitute a new species. Nor do genuine hybrids, crosses between two natural species, like the Kentucky mule. Exceptional, artificial, per accidens, they are the result of an unnatural, fortuitous concurrence of nature's forces and laws, or of man's skilful manipulation of nature's processes. They are not even systematic species in our sense, because they will never turn out to be natural. Hybrids of either kind have sometimes been called "Mendelian species", but the term "species" is then used in a wider sense; Mendel's laws have been verified only in them.

The unity proper to the natural individual is deficient in genuine hybrids. The unity which they do have, they cannot hand on to their descendants; either they have no descendants at all, or the descendants revert to the ancestral unity.

2. Also the answer to the second question is easy. No individual can belong to two species, for the simple reason that no being can have contradictory attributes.

However, the term "contradictory" must not be taken in a purely logical sense. It includes attributes which are naturally incompatible. For instance, the cells of one and the same individual cannot contain different numbers of chromosomes; one and the same organism cannot follow different rhythms of growth; one and the same animal cannot obey different instincts etc.

3. The third question is rather intricate and highly metaphysical, and would involve us in a discussion of the "principle of individuation", a problem much disputed among

Scholastics. For our purpose it will suffice to distinguish between complete and partial identity (or, what comes to the same, between complete and partial diversity). A drop of water is partially the same as the H or O of which it is composed. But if we adopt the scholastic theory of matter and form, we must say that the drop of water is simply a new individual. Likewise, if there were evolution from one species of plant or animal to another, e.g. if an individual duck would become an individual goose, we should simply have a new individual.

4. Only individuals exist in nature. Does it then follow that species are non-existent, figments of the mind?

Among English-speaking philosophers it is indeed a commonplace that terms which express genera and species are mere labels, words and names to which nothing corresponds in nature. According to John Locke "our distinct species are nothing but distinct complex ideas, with distinct names annexed to them" (*Essay,* Bk. 3 ch. 6 s. 13). The same doctrine was held by J. St. Mill, whose overpowering influence is still felt wherever the English language is spoken. The theory has also penetrated into scientific circles. In the body of his book on Plant-Breeding, L. H. Bailey is very positive about it: "Nature knows nothing about species; she is concerned with the individual, the ultimate unit" (p. 4). But in the Glossary, at the end of the book, his stand is less firm: "The species-group, he there says, does not necessarily represent an entity in nature".

P. Coffey (I p. 76) rightly doubts if these men really mean what they say: "Why do we give a thing a certain class name? Is it not because our concept of the thing includes the attributes we desire to signify by that name? And why does our concept of the thing include such attributes? . . . Obviously, we fix and determine the meaning of names by an *appeal to things*". There is then no call for

a surrender to English nominalism, a defeatist view of modern science as well as of all philosophy.

Still, we must distinguish. As we saw (supra p. 34-5), the term "species" may have three different meanings. If taken in the first, species certainly exist; there are groups of beings which must be joined in various species in accordance with the criteria. As regards the second meaning, Scholastics distinguish. Ontological species (direct universals) exist both in themselves and in our mind; they are realities and concepts. But the mode of existence differs. Outside the mind they exist individualized (e.g. this horse); in the mind they are abstract, i.e. without individuation (e.g. horse); and it is for this reason that they can be predicated of many individuals, that we can say this is a horse and that is a horse. Logical species (reflex universals), meaning either the complete essence with its relation to a group or (preferably) that relation alone, the third meaning of species, is a fiction of the human mind. It cannot possibly exist in itself; it is what the Scholastics call an ens rationis, a device peculiar to the human mind for prying into the secrets of reality. Still, it is not for that wholly fictitious; it may have a foundation in reality, viz. the essential likeness and unlikeness existing between the individuals of nature.[9]

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[9]Cf. Cotter, A B C etc. p. 190-4.

CHAPTER 14

Essences and Their Knowability

With this chapter we take a long step forward.

As has already been said, the 8 criteria of species discussed in chapter 9 tell us nothing about the intrinsic constitution of plants and animals. Taken by and large, they are rather extrinsic marks, something like street numbers, from which little or nothing can be inferred as to the kind of houses they designate. They distinguish natural groups, but do not tell us what is the *intrinsic difference* between species and species. Thus supposing that cats and lions belong to different species, one may ask: What makes them so different that one cannot be called a variety of the other? Why can they not be likened to pekinese and Newfoundlands, which all zoologists place in the same species?

Our purpose now is to find out if and how we can know the *essences* of biological species. But to have a solid foundation against modern skeptics and nominalists (J. Locke, D. Hume, J. St. Mill), we must first examine the *philosophical* notions and principles bearing on essences. Which, in accordance with ch. 1, are those of scholastic philosophy. Chapters 14 and 15 will be devoted to this task. One who is not interested in the purely philosophical aspect of the problem of species, may skip them.

The questions to be discussed in the present chapter are three: First, with regard to *essences in general* we may ask: Are there any essences of things at all? Can we know them, and if so, how? Secondly the same questions may be asked with regard to complete or *specific essences*. Lastly, owing to the vogue which the theory of *evolution* enjoys outside scholastic circles, we must ask if it would call for a change in the common scholastic doctrine on essences.

1. ESSENCES IN GENERAL

1. The essence of a thing is, according to Scholastics, that *by which it is what it is.* More explicitly, the essence of a thing is constituted by those ultimate and intrinsic attributes on account of which it *necessarily* is what it is. Man, for instance, is necessarily what he is because he is a rational animal. Essence is opposed to property and (logical) accident. Properties are not the essence itself, though they necessarily flow from it, and therefore are necessarily in the thing that has the essence. Accidents are not necessary to the thing; they may be present or absent, but they do not affect the essence one way or another.

2. That every natural individual being has its essence, is beyond the shadow of a doubt. Things not only are so, but *must be so* and cannot be otherwise—at least with regard to some of their attributes; and the reason for this necessity must be something in the things themselves. Now this something, the *ultimate reason* for those attributes and their necessity, is precisely what Scholastics mean by essence.[1]

In creatures, moreover, what is essential (including both essence and property), is *universal.* Not merely in the sense that it can be multiplied in an indefinite number of individuals, but that it will and must be found in every individual with that essence.

3. A distinction common among Scholastics is that between metaphysical and physical essence. The distinction is not always understood in the same sense; sometimes it is completely misunderstood.

The *metaphysical* essence is arrived at by comparing things with one another. It consists of two terms: one

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[1]The meaning is the same in English, as witness Webster's New International Dictionary.

expressing that essential note in which all objects of the same group agree, the other that in which part of them differ from others of the same group. It is called "metaphysical", not because it exists only in the abstract order, but because the distinction between its two terms is only logical and metaphysical, not real. Again the ordinary example given is that of man: rational animal. The whole man is animal and rational; the distinction between animality and rationality in man is only logical.

The term *"physical essence"* is much more ambiguous. It may mean the essence as actually existing, or the sum-total of the properties of a thing, or the scientific counterpart of the metaphysical essence (like Linné's descriptions). But it seems preferable to bring it in line with "physical definition" as commonly explained in logic. In this sense, the physical essence would give us the essential and really distinct parts of a thing—as when we say that man consists of body and soul. No comparison is necessary, but the thing itself is taken apart, as it were, to see what makes it tick.

Needless to add that in this view, if the thing itself exists, both the metaphysical and the physical essence exists. They are different, yes, but they are merely two ways of conceiving and expressing the same thing.[2]

4. The second question is: Can we *know* the essence of things?

But the limitations which we have set ourselves in this essay, entitle us to restrict this question. First, we pass over the essences of artificial things (chairs, typewriters, cork-screws etc.) ; since man himself created them, he can understand them perfectly and adequately—at least as far as they depend on his mind. Secondly, we leave aside mathematical

[2]Cf. Coffey, Ontology p. 78; Cotter, ABC etc. p. 373-6.

and mechanical figures (parallelograms, octahedrons etc.); like the productions of the artisan, these are constructions of our own mind and can therefore be understood perfectly by us. Thirdly, we omit the essences of spiritual substances (God, angels, the human soul) and qualities (habits, powers, virtues etc.), which occupied the minds of earlier generations of philosophers.

What we are after is this: Can we know the essences of *natural corporeal substances*? For it is these that constitute the modern problem of species. But note that we do not now distinguish between living and non-living substances.

John Locke, in his famous *Essay* (Bk. 3, ch. 6 ss. 2, 3, 40, 41), distinguished between nominal and real essence, and maintained by long arguments that our knowledge was limited to *nominal* essences of material things. This doctrine of his flowed more or less from his sensism. It is rather common in English-speaking countries, as witness N. Taylor. Speaking of plants, he says (p. 75): "What we must never forget is that whatever knowledge we have gained . . . is, after all, only a partial notion of them, as unsatisfactory as our estimate of what people really are, from merely looking at the outside of the houses in which they live. The outer form we may know and admire, the inner substance must ever remain for most of us a secret treasure house the value of which is certain, but the key to which we do not possess".

On the other hand, Pierre Rousselot argued that, all essences being simple and all definitions complex, no essence can be defined. That position, of course, would make our whole investigation abortive.

We shall not delay to refute either opinion at length. But first of all, all things of nature express God's thoughts and are imitations of God's essence. They are intelligible at least to God's all-comprehending intellect. Now our intel-

lect is an imitation, pro modulo suo, of the divine. Fundamentally then all things of nature are also intelligible to us. Secondly, we are not satisfied until we have reached the essences of things; our minds, being of a philosophical turn, are forever reaching out for first (or last) causes, and the essence of a thing, its real essence, is precisely its first (or last) intrinsic cause. Can we suppose that the deepest yearnings of our intellectual nature are doomed to eternal frustration? Rousselot's argument, finally, would destroy the truth of all our speech and cognition.[3]

The common scholastic doctrine goes even farther. Scholastics teach unanimously that the proper object of the human mind in this life is the quiddity of material or sensible things, and that we know the essences of spiritual beings only through them. If then we had no idea of the real essences of material things, we would know no essences at all.

5. The third question is this: *How* do we get to know essences?

It is a fact readily granted that we do not perceive them immediately, that is, without a process of reasoning. If it were otherwise, we should be able to tell offhand what is the essential difference between a cat and a dog, a rose and a lily, between silver and gold. But who could ever do so? No, the essences of natural things are not the object of "intuition".

Nor are the senses directly competent. Essences are something invisible, intangible, imponderable, imperceptible to any of the senses. The essence is the "intelligibile in sensibili", as the Scholastics said; it is the universal in the singular, the necessary in the contingent, the eternal in the temporal. The senses may and must furnish the raw material;

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[3]Cf. Cotter, *Cosmologia* p. 190.

but another faculty is needed to extract the essence from it.

And it is possibly right here that the most formidable obstacle arises to our whole investigation. Since the days of Francis Bacon, or at least since Locke and Berkeley, English philosophy has been definitely under the spell of sensism and nominalism. No distinction is made between sense perceptions, sense images, "associations of ideas" on the one hand and thought on the other. The distinction is, of course, fundamental in scholastic philosophy, so fundamental that it is taken for granted from the beginning. But I shall not now delay to prove it. The reader who is unfamiliar with it or does not see its bearing on the present questions, may be referred to the various manuals of scholastic philosophy.

6. To explain how we come by the essences of singular material objects, the Scholastics, after Aristotle, postulated an "intellectus agens" with a "habitus principiorum". That is, they endowed the human intellect with the power of *abstracting*.

Now abstraction is twofold. Sometimes the intellect grasps the essences of things by merely considering one or two instances, as when we form the concepts of number, extension, qualities, relations etc. Scholastics called such concepts "primitive", because they cannot be acquired any other way (e.g. by hearing a description of them) and are the foundation of all our intellectual life. They are not "innate", but the mind abstracts them readily, almost unwittingly, when it comes into conscious contact with reality.

The other mode of abstraction corresponds to what is called, in modern parlance, *induction,* scientific induction. As all manuals of logic explain, it comprises three distinct steps.

The first step is the accurate and painstaking *observation* of nature. Here, if anywhere, applies the scholastic axiom: Nihil est in intellectu nisi quod fuerit (aliquomodo) in

sensu. By means of our senses, we are to observe accurately and without bias the qualities and activities of the individual things of nature. Every primer of logic lays down the rules for this initial step, so that further comment is superfluous.

Comparing various objects, we shall soon notice that not all are alike. They are alike in some ways, but decidedly different in others. We therefore group together those which have some quality or activity in common, though they differ in it from other groups.[4]

At the third stage, we take a closer look at these same qualities and activities. With the help of more extensive observations or experiments we eliminate those which are evidently due to external environment, then those which are clearly infra-species. In the end we retain only those which are *absolutely constant* under the most varied conditions. How necessary this distinction is for animal classification, is well shown by G. S. Miller in the 1928 Report of the Smithsonian Institution (p. 401): "It is of prime importance", he says, "to distinguish between those peculiarities which are constant specific characters and those which are individual features of the sort normally occurring in the two sexes and in the various ages of one animal. Many specimens of each mammal must be examined and compared before the differential peculiarities can be clearly distinguished from those due to the diverse sorts of individual variation".

These constant characters are the *properties* of the thing. The descriptions of species contained in our manuals of

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[4]We may, if we like, bestow a *name* on this group, as do horticulturists, dog fanciers etc. However, at this stage, names are generally chosen for practical purposes. Scientific nomenclature has a different aim, as we shall see.

zoology and botany are meant to list them, giving the student what are called in logic "proper" definitions.[5]

Scholastics distinguish two kinds of properties. *Absolute* properties are those which primarily affect the individual itself (e.g. form and size); *relative* properties are those which govern external actions and reactions. But though relative properties do not manifest their presence except when brought into contact with other things, they are something intrinsic. To take an example from the inorganic world. Hydrogen is bivalent, viz. in relation to oxygen; contact with oxygen does not make it bivalent, but merely manifests this property.[6]

The foregoing supposes, of course, that science and philosophy work amicably hand in hand, science furnishing the hard facts, philosophy the outline or pattern for reducing the facts to a system. Actually things are less rosy. Philosophers would sit pretty if they could accept without further ado the definitions of zoologists and botanists. As things are, their first duty is to make sure that the so-called scientific definitions consist of *strict properties,* that is, that the qualities and activities enumerated in the definitions are absolutely constant.

Since properties are not the essence, there is one more step to take. But we had better discuss this under the next heading.

[5]Such descriptions or definitions, rather than the binomial system, were Linné's aim. Cf. *Universal Knowledge* s.v. Botany.

[6]Scholastics further inquire by what kind of *causality* properties originate, what is the *distinction* between them and the essence from which they flow, in which part of the individual they directly *reside* etc. But these and similar questions are distinctly philosophical and have no bearing on our particular problem. The curious reader will find them discussed at great length in Harper's *Metaphysics of the School.*

2. SPECIFIC ESSENCES

1. Scholastics distinguish between generic and specific essences.

By a *specific* or *complete* essence they mean the ultimate intrinsic reason for *all* the properties of a being. Thus, to take again our standard example, "rational animal" gives us the ultimate answer to all the why's that may be asked concerning man's distinctive traits. Man eats and drinks, sees and hears, judges and speaks, grows, lives and dies. Some of these man has in common with plants and brutes, others only with brutes, others finally are absolutely proper to him. But the ultimate reason for any or all of them is contained in "rational animal". The *generic* essence, on the other hand, is incomplete. It contains the ultimate reason for those qualities and activities which one natural group has in common with other natural groups, but omits precisely those which differentiate group from group. Thus animality gives us the reason why man has a body, why he eats and drinks, sees and hears, walks and sleeps. But it is silent on man's most distinctive traits,' such as speaking, praying, reasoning, improving himself etc. Man certainly does not do these things because he is an animal; else all animals could and would do likewise. A generic property is common to a whole genus, a specific property only to a species.

If the natural groups brought under a genus are species or lowest natural groups, we speak of a genus proximum or infimum, a *lowest genus,* and the distinguishing traits are called *specific differences.*

Determining the specific essence of a thing is a step beyond scientific induction. It demands not only knowledge of the properties themselves, but also insight into their *mutual relation,* or rather insight into the necessity with

which the properties flow from the essence as their foundation. Only then can we lay down a strictly *philosophical definition,* preferably metaphysical as described above.

2. Can we *know* the specific essences of material objects?

Our answer to this second question is a decided *yes.* The proof is the same as for the knowability of essences in general.

Nor need we except the *specific differences* of plants and animals, as do Fröbes, Sortais, Garrigou-Lagrange, Maritain etc. (supra p. 47-9). These differences are material, no doubt, but that does not make them absolutely unintelligible; if it did, no plant or animal could be understood by us—which is a hard saying and rather in line with Locke's position.[7] St. Thomas was not averse to limiting the non-intelligibility of matter.[8] But true specific differences are primitive concepts, to be gained only from experience (like odors or colors); they are also simple concepts, not to be further analyzed.

3. Let us beware, however, of demanding too much knowledge. In order to lay down the specific definition of a thing, we need not know the *proximate* answer to all the questions that may conceivably be asked about it. Though called "complete", knowledge of the specific essence does not suppose that we know all the properties of a thing, much less all its accidents.

Failure to note this led Locke to doubt if by studying properties we shall ever arrive at a knowledge of specific essences. "For, being ignorant of the real essence itself, it is impossible to know all those properties which flow from it, and are so annexed to it that, any of them being away, we may certainly conclude that that essence is not there, and

[7]Yet J. Endres calmly assumes it without further discussion (in Divus Thomas 1941 p. 302, 314).

[8]Cf. H. Meyer, Thomas von Aquin p. 80.

so the thing is not of that species. We can never know what are the precise number of properties depending on the real essence of gold; any of which failing, the real essence of gold, and consequently gold, would not be there" (*Essay*, Bk. 3 ch. 6 s. 19). As we saw, also some Scholastics were intrigued by such-like considerations and adopted the same pessimistic attitude.

But this is demanding the impossible. And to show that such complete, exhaustive, comprehensive knowledge of properties is not necessary for a specific definition, let me adduce two lines of reasoning.

a. Take an artificial product, the *automobile*. The Standard Dictionary defines it negatively as a "horseless carriage", positively as a "self-propelling vehicle". The latter definition may be understood by one who is neither a Henry Ford nor an expert mechanic nor a metallurgist. I doubt if Mr. Vizetelly, before approving the definition for the Dictionary, consulted any of these specialists, though they could have told him many things about the various parts that enter into the making of an automobile. The definition also seems specific. Webster adds some further details ("suitable for use on a street or roadway", various names, the mechanics and evolution of the automobile), which, however, constitute no essential differences.[9]

Similarly, when I am told that a certain building is a factory or a hotel or a church or a grain elevator, I know the complete essence, although I might learn more about the details of each by reading a description or studying the architect's blueprints or paying a personal visit.

b. There is probably no Scholastic who would deny that "rational animal" is the complete essence of *man*. Yet any number of man's properties were unknown to those who

[9]For practical or legal purposes, automobiles may have to be subdivided: motorcycle, truck, tank, pleasure vehicle etc.

first framed the definition and to the old Scholastics who accepted it; even we who know so much more about man's anatomy, physiology and psychology must leave room for further discoveries. There has been an increase of knowledge, but only of the *proximate* answers to various questions; the ultimate answer was not affected by it.

Therefore we are justified in distinguishing between actually and *virtually complete* knowledge of properties. Actually complete knowledge was what Locke demanded as the foundation for a specific definition; that was reaching for the moon. But we can have virtually complete knowledge, which includes the known and the unknown, the actual and the possible. And that knowledge suffices.

3. ESSENCES AND EVOLUTION

Even if the theory of evolution be accepted, the problem of species remains. Because descent from a common ancestor (like indefinite fertility) is merely an extrinsic mark, it tells us nothing about the nature of the descendants. Descent is generally thought to suggest identity of nature or essence, evolution change of nature; but neither the one nor the other tells us what that nature is.

Nevertheless, today we must face a question unknown to the medieval Scholastics. Does not the scholastic doctrine of essences, as explained above, imply *fixity* and *immutability*, and so prejudge the whole problem of evolution? Suppose evolution to be a fact, suppose that living organisms do change—slowly or suddenly, it matters not—would not the scholastic concept of essence lose its objective validity or applicability? Or would it, too, have to be revised in the light of our superior knowledge? If evolution is a fact, have we not started on the wrong foot?

The answer is *no*.

The scholastic doctrine of essence implies indeed that

abstract essences and their properties are immutable. The essence of a horse, surely, can never become the essence of a dog; nor could a horse become a dog and yet remain a horse; nor could a horse lose its properties without becoming something essentially different. These are incontestable truths, resting on the principle of identity, the first of analytical principles.

But the Scholastics never denied that an *individual* might lose its essence and acquire another. They were wrong when they believed with Aristotle in spontaneous generation, the development of maggots and reptiles and fish out of mud and decaying matter. They were wrong in holding with St. Thomas (Contra gentiles II 89) that the human embryo passes from mere vegetative life to the life of a brute animal, and thence to the life of a rational being. But they knew as well as we do that non-living food may be changed into living flesh by the process of digestion. Modern Scholastics also agree with the scientists that photosynthesis makes inorganic substances over into organic, that H and O may be converted into water, and that water may again be decomposed into H and O. Such changes the Scholastics called and call *substantial*, and a substantial change is nothing else than a change of essence.[10]

Still, if evolution were a fact, two changes would follow: a) It would reveal *a new property* (generic or specific) in those classes for which it has been attested by experience, and would therefore have to be taken into consideration in the framing of a definition. b) The *investigation*

[10]To some Scholastics there even appeared no absolute repugnance in having one *spirit* changed into another (cf. Hugon, Ontologia I qu. 2 a. 1). Though the opinion can hardly be said to have ever been common, yet it shows that Scholastics are far from rejecting essential changes a priori. But they differ from evolutionists in two things: They are aware of the metaphysical implications of such a change, and they want facts.

of natural species would become more difficult. For, though the Scholastics refuse to define substance as a "permanent being", yet permanency is a valuable guide toward determining substances and essences.[11]

[11]More on this point in Joyce p. 386-9; Boyer p. 111.

CHAPTER 15

The Cosmic Order

With this chapter we strike out on a new path, a path which, it is hoped, will lead us to the desired goal, the definition of biological species.

So far we have been considering species by themselves, as it were. But if we look around, we see that they are *part of nature,* integral parts of the order which reigns in this world. It is from the role which they play in this wider set-up that we shall (in ch. 18) derive the essential definition of species.

In the present chapter we begin by outlining the cosmic order in general, tracing it more particularly in the adaptation of the lower to the higher. Modern agnosticism and atheism also oblige us to touch on some stock objections against the existence of universal order.

1. ORDER IN GENERAL

Evolutionists go into rhapsodies over the order in the world. Witness a number of contributors to "The Great Design". But their order is based on evolution, which they pretend to see throughout the various realms of nature, more particularly on the *continuous progress* from the lowest being to man. If then this evolution and progress is not a fact, what else is such an order than a mirage, a city that the daydreamer sees in the fluffy summer clouds. Non tali auxilio.

If asked whether there is order in our universe, all but the most radical atheists and agnostics will reply in the affirmative. One need only open his eyes. Even prior to scientific and philosophical study, we are sure that *order is the first law of the universe.*

Let us briefly outline a proof.

At its head may be placed the words which the mother of the Maccabees addressed to her youngest son: "I beg thee, look at the heavens". What majestic order is there manifest, even to the untutored savage. Though star differs from star, and though the sky is filled with thousands and millions of them, yet is there perfect order. The stars do not follow the principle of rugged individualism; they are incorporated in ever widening systems, and so coordinated and subordinated as to constitute truly what the Greeks called a "cosmos", a thing of beauty. Nay more, though the single stars as well as the systems to which they belong, are in perpetual motion and swing through space at an incredible speed, yet has the world endured as a cosmos for thousands, perhaps for millions and billions of years.

The Maccabean mother knew nothing of the marvels which modern astronomy displays before our eyes. But her *common sense* sufficed to let her see in the heavens the handiwork of God. The discoveries of these last centuries, far from weakening this obvious conclusion, only confirm it. They have revealed unsuspected wealth in the truth which the psalmist of old proclaimed to Israel, and which Haydn enshrined in his majestic oratorio: "The heavens narrate the glory of God, and the firmament announces the work of His hands" (Ps 18:2). Now it is precisely the order which we observe there that narrates the glory of God and proclaims the heavens to be His handiwork. To none more than to the modern astronomer. To Aristotle, the pagan, God was a necessary postulate because wherever he looked, he saw design and order.

If scientists or philosophers at times put forward statements at variance with this homely truth, let no one waver in his conviction. The truth is not only well-founded, but pertains to that patrimony of common sense which all re-

ceive from their parents and teachers, and which every unbiased scientist and philosopher should take pride to defend and confirm.

2. ADAPTATION OF LOWER TO HIGHER

But let us come down to earth.

Even to the untutored mind it is evident that not all things on this earth are on a dead level. There are lower and higher. At the base is the inorganic world, the realm of lifeless matter. Among the beings endowed with life, we clearly distinguish plants from animals, putting the latter in an essentially higher class. Finally, man is evidently the crown of creation.

Now without losing ourselves in particulars, we can certainly make this assertion: Wherever we look, we find that the lower orders of beings are *for the benefit* of the higher.

Take the *inorganic world,* I mean the chemical elements and their combinations, the special conditions of light and heat, the peculiar constitution of the air, the distribution of seas and continents, the succession of day and night, of the seasons—and so on. Do they not aid the higher orders to be and to live? And are not the higher orders so equipped by nature as to benefit by their aid? Nay, could the higher orders live and attain their purpose in life except through their aid?

Again, *plant life* is evidently for the benefit of animals. Plants are so constituted that they can live on inorganic substances, which no animal can. But in the process of photosynthesis they prepare those bio-chemical or "organic" substances (starch, albumen, hydrocarbons) without which animals cannot exist, although they themselves cannot manufacture them. The different classes of herbivorous animals in their turn are marvelously fitted to feed on special plants; their teeth and their stomachs are made for just

such diet. Not only that, but their instincts guide them in their choice, and the construction of their senses harmonizes with that purpose.

Lastly, no one need be told how useful *animals* are for men. Would it be unscientific or prescientific to say that cows are meant to provide us with milk, sheep to give us wool, cats to guard human habitations against undesirable rodents, horses to supplement man's power of locomotion?

A concrete example will give us a bird's eye view of the beneficent workings of *all the realms of nature* in the interest of man. I quote from an article in the *National Geographic Magazine,* Aug. 1936, entitled "Sea Creatures of our Atlantic Shores", by Roy Waldo Miner, Curator of Marine Life, American Museum of Natural History. After describing the *oceanic shelf* of the Atlantic coast, he continues: "Throughout this extensive and comparatively shallow oceanic margin, well illuminated by the sun's rays, conditions are favorable for an enormous development of the marine plants on which sea animals feed: namely, the microscopic diatoms, one-celled algae, and the larger seaweeds. Here numerous streams empty their loads of silt, rich in nitrates, phosphates and other chemicals needed for plant food. The strong tides rushing into the narrowing channels from the open sea keep the water stirred with upwelling currents plentifully supplied with oxygen. Hordes of small crustaceans, the copepods, feed upon this plant life. At certain seasons they swarm in these waters in numbers so vast that they give the sea a reddish color for miles. These tiny creatures are rich in oils and are greedily devoured by large schools of mackerel, herring alewives and shad. Bluefish, cod, hake, and haddock pursue and devour the smaller fishes, and even the huge finback and humpback whales do not disdain to feed upon the herring. Thus the shallow banks off New England, especially Georges and Browns

Banks, at the entrance to the Gulf of Maine, as well as the Grand Banks of Newfoundland, further away, form a veritable nursery for the important food fishes of our coasts, and thus connect mankind by an interlacing food chain with the microscopic life of these shallow waters". Similar phenomena on other coasts (England, Southern California, Chile, Peru) are described by Prof. Yonge (p. 221-5).

Prof. P. E. Raymond of Harvard gives us this summary at the end of his "Prehistoric Life" (p. 308): "Nature has somehow struck a balance favorable to the present proprietors of the earth".

Theologians, lifting their eyes above the materially useful, tell us that all irrational creation displays to man the wisdom and power and goodness of the Creator, thus compelling him to love and praise God more fervently.

3. UNIVERSAL ORDER

But can we say that there is order everywhere? Are there not numerous instances of so-called dysteleology, beings that do not seem to fit into the general scheme of things? Those cases of flagrant disorder which materialists like Lange and Feuerbach or cynics like Voltaire and Diderot parade before their readers—are they pure fiction? Do we not make fools of ourselves if we insist on maintaining that there is order everywhere in this universe of ours? What shall we say of the ubiquitous mosquito, and particularly of the malaria-carrying kind? Or of the gypsy moth brought to New England in 1869 and now stripping our oaks, willows, appletrees etc. of their foliage? Or of the prolific boll-weevil, the scourge of our cotton states? Or of the corn-borer, which has spread within a generation from the Atlantic coast to the Mississippi? The fact is that of the 75,000 kinds of insects in North America 6,500 are estimated to be injurious to agriculture; and there are estimated to be

in the world 20,000 harmful insects not yet found in the U.S.A.[1]

Again, while plant life is, on the whole, beneficial to mankind, are there not objectionable weeds, poisonous plants, some deadly species of bacteria? Or can we accept C. J. Hylander's excuse, who admits it, but calls these "an insignificant minority" in comparison to the vast majority of useful plants (p. 3)?

Finally, let us not forget the many species of plants and animals which, as geology and paleontology teach, have become extinct in past ages, a process still going on. Do not such facts manifest a tendency on the part of nature to get rid of harmful species and useless adjuncts?

Without entering into innumerable particulars, we can give a threefold general answer to these and kindred objections.

a. *Our understanding* of the world and its order is very imperfect. But although we admit cases of apparent disorder, yet can we confidently assert, a priori if you will, that order is universal. Let us begin with an illustration:

Take the ordinary typewriter. There is evidently order between all its manifold parts. One who knows typewriters, is easily convinced. Also the firm which put them on the market, made sure of it beforehand; else, on account of useless gadgets, the price would be excessive, or some interference might hamper smooth operation. Now suppose a man comes along to whom typewriters are a complete novelty. Would he not be justified in thus reasoning with himself a priori when his lay mind might be inclined to judge certain parts of a typewriter superfluous, useless, perhaps unsuitable? Therefore, though he might fail to understand the use of certain levers or wheels or keys, yet

[1]Cf. *National Geographic Magazine,* Aug. 1941 p. 225-248. A long list of "pests" may be found in Hegner's *College Zoology* p. 299-301.

could he be sure that they fit in with the general idea of typewriters.

Let us now make the application. Once we suppose that an *all-wise God* created this universe, can we not argue a priori that there must be order everywhere? Can we not assert confidently that there is order even where we, owl-eyed mortals, perceive little or none of it? Can we not defy those blatant materialists and cynics who gloat over a few instances of apparent disorder? We should have the right to put to them the questions which "the Lord" put to Job in the 38th and 39th chapters, and which evidently express the mind of the sacred writer. Or we could ask them the questions addressed by Isaias to the materialists of his age: "Who hath forwarded the spirit of the Lord? Or who has been His counselor and hath taught Him? With whom hath He consulted, and who hath instructed Him and taught Him the path of justice and taught Him knowledge and showed Him the way of understanding" (Is 40: 12-13)?

Quoted throughout the centuries without losing an ounce of its force has been St. Augustine's observation on the same objections. In his time the Manicheans used to twit uneducated Catholics (infirmos et parvulos nostros) who could not answer their attacks on the Old Testament. Against them he wrote "De Genesi contra Manichaeos", a defence of the first chapter of Genesis. Regarding v. 24-25 he says: "Here the Manicheans ask: Why should God have created so many animals on land and in the sea which are useless for man? And many of them are harmful and dangerous". Listen to St. Augustine's classical reply: "When the Manicheans talk thus, they forget that all things are beautiful in the sight of their Maker, who uses them for the running of the universe (ad gubernationem universitatis), over which He has absolute control. Suppose an idiot (imperitus) enters a craftsman's shop. He will see there

many tools whose purpose he does not know, and if he is very stupid will judge them useless; and if he should be careless enough to burn himself at the hearth or cut himself while fooling with a sharp-edged tool, he will draw the conclusion that the shop is full of evil and dangerous things. But the craftsman, who knows the purpose of his tools, will laugh at his stupidity and keep on working no matter what his visitor may say. Now think of the stupidity of men. In a workshop they do not dare to criticize what they do not understand; they rather suppose that everything is necessary and intended for a definite purpose; but in this world, whose Maker and Ruler is God Himself, they have the audacity to criticize many things because they see no reason for them; concerning the works and tools of Omnipotence they pretend to know what they do not know".

b. Our second answer is this: This world is only *relatively perfect,* and so is the order of this world.

No doubt, we read in Genesis 1:31 "And God saw all things He had made, and they were very good". Also, Scholastics defend the thesis that all things are good—for themselves and for others. But neither assertion means that all things are absolutely perfect in themselves or that all are beneficial to everything else in every respect. There may be and there are things harmful in some ways to man and animal and plant, such as weeds, poisonous snakes, death-dealing germs and bacilli etc.; there are cyclones and droughts and epidemics; there are ghastly accidents and ghastlier crimes. But we deny flatly that such things serve no good purpose whatever, that they are wholly bad, that they had better be eliminated altogether.

c. Nor is the *extinction of species* a sign of dysteleology. Without undertaking the justification of the disappearance of this or that particular species (e.g. the dodo), we may ask: May not these species have been necessary and bene-

ficial in an earlier epoch of the world's history? And may they not have become superfluous or harmful as time went on? But if this world was created and formed with a view to the coming of man, even extinct species of plants and animals were useful to him *indirectly*. They were needed in their time to prepare the world for his coming.

CHAPTER 16

The Balance of Nature

The most breath-taking aspect of the cosmic order is the balance of nature or web of life. It is nature's own perpetuum mobile, a most ingenious device to keep the universe and the realms of life going amid all the changes inherent in them; it is unceasing action and reaction between various classes of being, so geared one to the other that the existing order seems indestructible.

The concept of the balance of nature in its broad outline is nothing new. But modern science has uncovered some of its mechanisms that are truly superhuman in their ingenuity; on the other hand, man today realizes better the disastrous results which invariably ensue when this delicate balance is carelessly upset. Let us now see a few illustrations of the positive working of the balance of nature, and then instances where it was disturbed by man's greed or ignorance.

WORKING OF THE BALANCE OF NATURE

1. Take the *oxygen of the air.* Animals, man included, feed on plants, or on animal products which were originally built up from plants. These foodstuffs consist, chemically speaking, of carbon which the animal combines with the oxygen taken from the air by means of respiration. In the organic process of combustion oxygen combines with carbon to form carbon dioxide, which is again exhaled.

Were this one-way process to go on, the oxygen of the air would in time become exhausted, carbon dioxide would accumulate, and universal death would result. But nature knows the answer. The chlorophyll of plants is capable, with the aid of sunlight, to decompose carbon dioxide into

its elements; the carbon thus liberated is utilized by the plant to build up its own body; the oxygen is returned to the air.[1]

2. Another striking example of the balance of nature is *nitrogen,* one of the essentials of plant food. "Ordinary plants have not the power to take free nitrogen from the air, where it exists in almost unlimited quantities, but absorb their nitrogen from certain nitrogenous substances in the soil. This element of soil fertility is soon exhausted. Leguminous plants (clovers, beans, peas), however, produce on their roots small tubercules containing bacteria which have the power to take free nitrogen from the air in the soil and put it into a form suitable for plant food. By the death and rotting of the plant, the nitrogen thus absorbed from the air is incorporated in the soil and is available as food for all sorts of vegetation. In this way the leguminous plants are almost indispensable for the rehabilitation of soils worn out by excessive cropping" (Encycl. Amer. s.v. Botany).[2]

3. The balance of nature is perhaps nowhere better illustrated than in the phenomena of *reproduction.*

Nature's *fecundity* is well described by L. H. Bailey (p. 39-40): "If all the seeds produced by the elms on Boston Common in any fruitful year were to grow into trees, this city would become a forest as a result. If all the seeds of the rarest orchid in our woods were to grow, in a few generations of plants even our farms would be overrun. If all the rabbits which are born were to reach old age, and all their offspring were to do the same, in less than ten years every vestige of herbage would be swept from the country, and our farms would become barren. . . . And then fancy the result if each of the animals, from rabbits and mice to frogs and leeches, were to increase without check. The

[1]Cf. MacDougall p. 62-3.
[2]Cf. MacDougall p. 63-4.

plagues of Egypt would be insignificant in the comparison".

But nature takes care that the number of *actually existing* individuals of different species be balanced. Some animals lay only a few eggs each season, others lay them by the millions, as we saw in the oyster. Casualties, enemies and competitors of the former are few, of the latter many. "Boll weevils lay so many eggs and have so many generations a year that one pair in a single season could produce some 12,755,000 descendants, if none was killed by man or Nature. Actually, they have numerous enemies, chief of which are winter cold and blazing summer heat" (F. G. Vosburgh, in *National Geographic Magazine,* Aug. 1941 p. 231).

But nature's regulatory power goes still further. There may be *fluctuations,* over long periods of time, in the actual number of individuals; certain species at least have their cycles of scarcity and abundance. Here at Weston, for instance, squirrels which were plentiful, disappeared almost completely about the time of the 1938 hurricane and are coming back very slowly. In the long run, it seems, each species holds its own and no more.[3]

Under the same head falls another marvel of nature, the constancy of the numerical relation between *male and female.* The facts are too well known to need rehearsal. In every species of plant or animal where reproduction calls for two sexes, the ratio of the number of individuals pertaining to either sex has remained the same through the ages. A like phenomenon is seen in animals which live in *colonies.* In beehives the numerical relation between queen and workers and drones does not change. Not that the number is always exactly the same, but it never departs

[3]Cf. J. G. Needham p. 73; Thomson's *Outline* p. 657; Yonge p. 237-8; Hegner, *College Zoology* p. 8; *Universal Knowledge* s.v. Bird col. 872.

widely from a healthy average, except under the influence of external causes, in which case the aberration is either rectified by nature or leads to the extinction of the colony.[4]

4. We have said in the last chapter that the lower orders of nature were evidently created for the higher. But that is not the whole story. There are two classes of phenomena which modify this general statement.

In many species, there is *give and take.* The berries of the mistletoe serve the thrush for food. But the thrush wipes the seeds off its bill on whatever branch it sits, and the seeds adhere firmly to it as the glutinous juice dries. This is just the position needed for the new mistletoe, a parasite, to germinate in the following spring. Or look at the waterfowl. It feeds along the edges of swamps, but when rising lifts little dabs of mud in which there may be a dozen seeds, carrying them to fresh marshes. The same mutual aid is seen in honey bees, hornets etc., which take the nectar from some plants and help in the cross-fertilization of these plants. An example of an almost perfect mutual adaptation of plant and animal is the yucca moth as described in Hegner's College Zoology 'p. 282-3, 300.

Any number of animals seem created, though perhaps not primarily, to confer some *benefit on plant life,* a lower order.

The blue jay is often considered a mere nuisance; he is accused of annoying other birds and stealing acorns from squirrels' caches. But an article in "Life" (June 1, 1942), shows that the small mischief is more than balanced by his work as a forester. Because blue jays bury acorns well uphill from trees, oak forests, which ordinarily spread down the slopes of hills, can cover mountain sides to the very tops.

A defence of the skunk, sent to the *Boston Herald,* Nov.

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[4]How, in all these cases, the proportion of numbers is actually brought about is still a dark mystery.

27, 1935, makes interesting reading in view of the unsavory reputation of that animal. W. Oliver, of Danielson, Conn., writes: "Recently I read a notice of a New England community making a particular effort to destroy skunks. The average person seems to think that the only good skunk is a dead one. . . . On the contrary, no gardener can wish for better friends. Our skunk's main business in life seems to be the capture of those big white grubs of the June bug. Those grubs are most destructive to the roots of all forms of garden vegetation and even to grass. Judging from the number of little drill holes made, the skunks must eat thousands of grubs. . . . Killing skunks is simply multiplying, beyond computation, the number of insect plagues which already ravage our gardens and fields". The *N. Y. Times* of Dec. 16, 1941 carried an item that must have tickled Mr. Oliver if he saw it. Wildlife experts testified to the economic importance of the skunk. "Skunks are mostly beneficial to man", declared the officials of the Fish and Wildlife Service. "They are important to agricultural interests because they feed on insects, chiefly beetles and grasshoppers, grubs and other forms of pests". Excellent mouse and rat hunters, they are welcomed around lawns and in the fields where mice and rats like to feed on grain.

In the *National Geographic Magazine* of July 1935, John A. La Gorce sketches a delightful picture of the working of the balance of nature in Pennsylvania before the advent of the white man. He quotes an "eminent game conservationist" as saying: "In the work of policing, protecting and preserving the forests which stood here when Columbus arrived, birds and beasts each served in his sphere, performing a useful work for which the Great Spirit created him. Bears, the white-wings of the forests, tore to pieces the rotten logs in search of grubs, ants and other insects, tore out stumps to make room for new trees, scattering the

fragments on the forest floor, where they disintegrated and became fertilizer. The deer, elk, rabbits and other grazing and browsing animals destroyed weeds and pruned the trees, throwing the growth to the tops, making timber. Turkey, grouse, and other birds destroyed the ground insects. The woodpecker family policed the trunks and larger branches of the trees, while the large family of warblers and other species of small birds cleansed and protected the foliage. The squirrels planted nuts and the birds distributed the seeds, while the industrious beavers built dams which conserved the water. To the birds and mammals we owe our forests and to the beavers the finest meadowland in Pennsylvania".

In the N. Y. *Catholic World* of April 1929 there appeared an article entitled "Through the Eyes of the Naturalist". What the author, Frank H. Sweet, there relates of the specific activities of some of our common birds in procuring their daily food is so much to the present and other points of our essay that I take the liberty to quote a rather long passage.

"The manner of foraging is widely different in the various families (of birds), and it is interesting to note the assiduity with which insects are hunted in all stages of their existence. In their larval state, those that lurk inside the wood and bark of the tree are taken by the woodpeckers. Insects, when the larvae have assumed the form of moths, beetles and flies, are attacked by flycatchers and sylvians and other small birds that take their food by day, and by small owls and whippoorwills by night. Birds that take their food chiefly from the surface of the ground forage in a different manner from those that collect it from under the surface. Robins and blackbirds gather their fare entirely from the ground, but their ways of doing it are different. Swallows catch their food while on the wing, and by this give proof that they take only winged insects; but their manner differs

essentially from that of flycatchers, which do not take their prey on the wing, but seize it as it passes by their perch.

"Among the smaller birds, the kinglets and gnatcatchers are remarkable for their diligence in hunting. They have a peculiar way of examining the foliage and blossoms rather than the surfaces of the branches, and their motions are very conspicuous upon the outer parts of the trees near the extremities of the twigs. The gnatcatchers especially are exceedingly active and graceful, and take insects on the wing with wonderful dexterity. On the other hand, the chickadee, creeper and wren seek their food while creeping round the branches, and take very little of it from the foliage. Round and round they go, seldom pausing in their circuitous route, and usually proceeding from the junctions of the branches to their extremities, hopping from spray to spray, and then passing on to another tree. As the kinglets and gnatcatchers confine themselves almost exclusively to examining the foliage, they go when the leaves fall; the bark protectors, however, remain long after the trees are bare, and not infrequently through the entire winter.

"The wood peewee may be taken as a good example of the flycatcher family. His manner of foraging is to sit on a twig, keeping his body almost rigid, but with a frequent movement of the head indicative of watchfulness. That he is not idle is shown by his flitting out in an irregular circuit and immediately returning to his perch with a captured insect. These salient flights are very numerous, and he frequently turns a somersault in the act of capturing his prey. He rarely misses his aim, and often captures ten to fifteen insects of appreciable size in a minute.

"Forming an intermediate genus between the sylvians and flycatchers, and partaking of the habits of each, are the vireos. These birds are peculiar to America, and all are gifted songsters. Some of them, indeed, keep up a sort of in-

termittent singing even when hunting for food. The preacher vireo, especially, seems to make warbling his principal occupation. He is never, apparently, very diligent or earnest, but often stops during his desultory exhortation to seize a passing insect, and then resumes his song.

"Among other natural guardians of the trees are woodpeckers, which gather their food as they creep around the trunks and branches. They have two toes in front and two behind for climbing, and may usually be seen clinging erect on tree trunks, but rarely, if ever, with head downward, like the nuthatches and titmice. As the food of the woodpeckers is nearly as abundant in winter as in summer, they are seldom migratory. They never forage in flocks, like some of the carnivorous birds, but scatter over wide areas, and thus better their fare. They bear the same relation to other birds that take their food from trees, as snipes and woodcocks bear to thrushes and quails—that is, they bore into the wood as the snipe bores into the earth, while quails and thrushes seek the insects that crawl on the surface of the ground.

"Besides these there are the few birds that take part of their food from trees and the rest from the ground. The thrushes do not refuse an insect or grub that is crawling upon a tree, but they forage chiefly upon the surface of the ground. The blackbirds are also guardians of the soil, and are apparently far more industrious than the thrushes. However, a little observation will correct this delusion. The common robin hunts his food in a nonchalant way that is very deceptive. He hops about the field with his bill turned upward in listless unconcern. But presently there is a quick dart and a vigorous pecking upon the ground, and if you are near enough, you will see him pulling out a cutworm or devouring a nest of insects which are gathered in a cluster.

"On the other hand, blackbirds seldom hold up their

heads, but march along with their bills turned downward, as if entirely devoted to their task. They never seem idle, except when a flock of them are making a garrulous noise upon a tree. If a blackbird looks upward, it is only by a sudden movement; he does not stop. After watching a blackbird and a robin ten minutes in the same field, one would suppose that the blackbird had collected twice as much food as the robin during that time. But this would not be true. The robin is probably endowed with greater range of sight than the blackbird, and while hopping about with his head erect, his vision comprehends a wider space. He not only watches for a sight of his prey, but also for marks upon vegetation that denote the place of its concealment. The omnivorous blackbird hunts the soil for everything that is nutritious, and picks up small seeds that require a close examination of the ground. Blackbirds of all species walk. They do not hop like the robin.

"Some species of foragers do their work in compact groups. This habit renders the snow bunting so extremely attractive. Their food is not distributed in separate morsels like that of robins and woodpeckers. It consists of the seeds of grasses and of composite plants, which are often scattered evenly over a wide surface. When a flock of fifty or more settle down in a field, each one fares as well as if he were alone, during the short time he remains on the spot. Insect feeders find it for the most part profitable to scatter and keep separate, because their food is sparsely distributed. This is not true of the birds which frequent salt marshes that are overrun by the tide. Their food consists of insects and worms which are evenly scattered and abundant. Hence sandpipers and some other species forage in flocks, though they live exclusively upon an animal diet.

"The foraging habits of domestic poultry illustrate some of the differences observed in the manners of wild birds.

Place a brood of ducks in a field during grasshopper time and they will generally pursue one course, marching in a body over a field with great regularity. A brood of chickens, on the contrary, will scatter, occasionally reassembling, but never keeping close together, unless they are following a hen. Turkeys scatter themselves less than chickens, but do not equal ducks in the regularity. Pigeons settle down upon a field in a compact flock, and radiate in all directions. They pursue no regular march like the ducks".

Though much in this long passage has no direct bearing on the balance of nature, yet it illustrates a number of factors entering into the problem of species.

5. A last feature of the marvelous balance of nature is the *economy of nature.* Nature is sometimes accused of being lavish. But she is also a great economist and loves to make the same tool serve diverse purposes. Plants serve animals for food; yes, but they also help in purifying the air and forming the soil; they provide dwelling places for animals and throw a garb of beauty over the unsightly inorganic world. Or consider the manifold activities of earthworms, to which Darwin devoted so many years of his life. Bruising the earth in their gizzards, they make soil-solution easier; they make burrows which aerate the soil and open it up for rootlets and rain; they bury the surface with castings which they bring up, turning the soil round and round in the course of time; finally they bury leaves, which rot away into vegetable mold.[5]

UPSETTING THE BALANCE OF NATURE

The attention of scientists might never have been centered on the balance of nature, had it not been for the dis-

[5]Cf. Thomson's *Outline* p. 644.—Note that this principle of economy is not the same as that of "parsimony" or "least action" excogitated by Maupertuis and much discussed in the 18th century.

astrous effects which resulted from its neglect.[6] Let us look at a few instances in which it was ignored or ruthlessly set aside.

A series of articles on "Forests and their Destruction" in the *Social Justice Review* (Aug. 1942 to Febr. 1943) gives a historical survey of the sad effects of deforestation in many lands: Palestine, Asia Minor, Cyprus, India, Mongolia, China, Greece and so on. In most cases, it was the desire of more farmland which led to deforestation, but deterioration of the whole climate was the net result.

In the article mentioned (supra p. 145-6), John O. La Gorce describes the new era which the white man's greed ushered in in Pennsylvania: "When William Penn came to America, he had title to some 28,000,000 acres of woodland, mountain and dale. For a dozen decades these forests yielded only to the settler's axe and his new-ground ripping plow. The larger towns and cities began to grow and there was an insistent demand for lumber. Williamsport alone had thirty-three large sawmills, and its log booms often contained as many as 300,000,000 feet of unsawed logs, each branded after the fashion of cattle on the range. Many a millionaire was made by the industry and many a bank founded its strength in the towering trees laid low for the march of building. This havoc went on until there was left in all the 28,000,000 but a beggarly 20,000 acres of virgin timber. The lumberman had left his tree tops and his sawdust piles to make the most dangerous of fire hazards on millions of acres and to render a thousand streams unfit for fish life. Forest fires completed the destruction, and millions of blackened, barren acres stood as mute witnesses of the profligacy of man in wasting one of the Commonwealth's principal assets. Floods became more frequent, since bar-

[6] Cf. MacDougall ch. 49.

ren lands cannot hold back water to keep streams fed in dry weather. Fish by the million perished when the streams were transformed for long periods into dry river and creek beds".

Slowly the thinking citizens of Pennsylvania awoke to the wastefulness of such barbarous methods. State agencies and private enterprise joined hands to reestablish the balance of nature. Today 13,000,000 acres are again covered by forest. And the result? "Reforestation is beginning to bear major fruit. Floods are becoming rarer and less destructive, for water is absorbed instead of rushing pellmell riverward. Springs constantly fed by seeping water in turn fill the streams with a more constant current. Fish are accordingly increasing in substantial numbers due to steadier stream flow, seasonal restrictions, bag limits, and artificial propagation. The reborn forest has stirred into being a new wild life".

The fourth decade of the present century has taught the Middle West a painful lesson of what happens when nature's smooth working is interfered with. Instead of speaking in generalities, let me cite the personal experiences of Jay N. Darling as narrated in the *Saturday Evening Post* of Sept. 21, 1935.

His father's farm had once bordered on a "slough", a "reed-fringed sheet of water", which "away from the prairies would have been called a lake or pond". "There were countless other sloughs and there was good hunting around almost any one of them. At our slough the ducks would arrive in spring and remain until fall. These places were nesting grounds". A country boy's paradise, as the author assures us, and a hunter's kingdom.

Came the usual story of economic myopia. "Along in 1908 or '09 a twelve-foot drainage ditch was dug to connect our old slough with the county drainage system; all

of its water was drained off. That was held to be an example of wholly admirable progress. The intention was to add the slough bottom to the arable land of the farms of which it had been the center. Except for its margin, the slough bottom proved to be unfit for cultivation; it was gumbo clay. The last time I saw my uncle I asked him if there was any water back in the old slough. He shook his head; it had become just a barren, a weed patch. Obviously, it could no longer be a resort for ducks".

Then enlarging his vision, Mr. Darling notes that the same short-sighted policy had laid waste a vast area between the Mississippi and the Rocky Mountains. "Myriads of lakes and sloughs had been transformed into dry barrens, where dust was raised by every passing breeze. The water ordinarily stored in the earth within reach of any half-way enterprising well-digging effort had sunk too low to be found by ordinary means of measurement. Seed remained unsprouted in the soil. Droves of gaunt cattle wandered over the dusty land with tongues protruding, all their bony structure showing. There were dreadful dust storms. It is significant that the factor that had made that great area impossible as a breeding ground for ducks, had also made it for the period of the drought, unsuitable for man or any of his domesticated creatures. . . . During half a century, just about everything men did as they took a tighter grip on the interior of the continent, destroyed more of the nesting ground of water fowl, and likewise worked to bring on the years of drought".[7]

Americans are not the only ones to learn this lesson to their sorrow. The case history of the New Zealand rabbit

[7]It is a pleasure to record that a plan has been approved by Congress to use the waters of the vast Missouri basin to reclaim the thirsty land (see *National Geographic Magazine*, Nov. 1945). A similar experience of dwindling numbers of ducks in three prairie provinces of Canada is narrated in the *Reader's Digest*, Febr. 1946.

is well known. Thomson's "Outline of Science" (p. 656-8) reports two instances, one from Australia, the other from England. "On certain Murray River swamps several species of cormorants used to swarm in thousands, but ruthless massacres, ordered on the supposition that the birds were spoiling the fishing, reduced them to hundreds. But the fishing did not improve; it grew worse. It was then discovered that the cormorants fed largely on crabs, eels and some other creatures which devour the spawn and fry of the desirable fishes. Thus the ignorant massacre of the cormorant made for the impoverishment, not for the improvement of fishing". The case in England has to do with squirrels. "Anti-squirrel clubs have been started because of the damage done to young trees. A price is put on the beautiful rodent's head, and the heads come tumbling in. Sometimes, however, the squirrel club has had to be dissolved, because of the over-multiplication of wood-pigeons, which eat enormous quantities of grain, and may mean a serious loss to the farmer. The usually vegetarian squirrel levies toll on the young squabs of the wood-pigeon.[8]

Are we then forbidden to get rid of *pests?* Must we accept the principle which Dr. Heiser (p. 460) attributes to Ghandi? According to the *Times* of India, Ghandi maintained that "we have no right to take the lives of mosquitoes, flies, lice, rats or fleas. They have as much right to live as we".

The answer would only be partial were we to say that Ghandi and we start from different premises, and that Ghandi misjudged the relative importance of things. Surely, if there is a clash between the life of the malaria-carrying mosquito and that of human beings, no sane man doubts whose life is doomed; only a fanatic will come to another

[8]Other instances in Yonge p. 233-241, or in Audubon, *The Birds of America* p. ix.

decision. God Himself, on the day of creation, gave man command over plants and animals.[9]

But do we not thereby disturb the delicate balance of nature? Why indeed did God create these beings except as parts of the web of life? And the problem becomes even more disquieting when we take into account modern hygienic measures, which do not stop at killing off a few individuals of the noxious species, nor at cleaning up some particularly bad locality, but aim at complete extermination.

The full answer is that man should first study the balance of nature, that he should get at the facts before, not after, he has recourse to drastic steps. Thus the author of the article on deforestation suggests that forests should not be left to individual caprice, but should be placed, to some extent, under the control of the community. The officials of the Fish and Wildlife Service, quoted above on the usefulness of skunks, advise us to control such unwelcome guests under the farmhouse rather than dispose of them; the news item does not enlarge on the method. Concerning birds, some of which are the farmer's bane, "Universal Knowledge" (s.v. Bird, col. 872) offers the following suggestions: "It is recommended that most native species be given some protection, many almost complete protection, and that attempts should be made to protect crops, if possible, without exterminating any species of bird; for example, wild fruits planted about an orchard will make robins or waxwings less damaging to the cultivated fruits".[10]

[9]According to a press report (July 1946), Ghandi now allows the killing of monkeys, who cause so much damage to the farmers of India.

[10]Cf. Chidester p. 199-201.

CHAPTER 17

Extrinsic Purpose

Though the last two chapters seem to have wandered far afield, yet they have actually taken us into the very heart of our theme. They have shown us that the present world order is extremely complex, infinitely delicate, and yet constant; at least it has persisted for hundreds and thousands of years, and in spite of the atomic bomb, there are no signs of an early break-up.

Now such an order supposes *intelligence* working for a *purpose*.

I know that the word "purpose" has long been taboo in scientific quarters. "Science today dispenses with the notion of purpose in studying structure and behavior, among living things as among galaxies and atoms", says B. C. Gruenberg (p. 454). What cannot be counted and weighed and measured, is, since the days of Descartes and Francis Bacon, ignored, if not denied outright. This practice obliges us to be more philosophical in the present chapter than we should wish.

We shall first discuss purpose in general, then purpose as manifest in nature, and lastly extrinsic purpose, a notion unfamiliar, it seems, even to philosophers.

1. PURPOSE IN GENERAL

"Purpose" is one of those primitive concepts which are hardest to define. We abstract them immediately from experience or we do not have them at all. Still, all are familiar with the concept of purpose, at least as far as it applies to human activity.

Let us suppose for example that I want to catch the 8:10 train. I have in my mind the picture of the train, its leav-

ing the station at 8:10, the bus that will take me there, the three blocks to the bus etc. And with this picture in mind, I leave my house at 7:40, catch the bus at 7:45, arrive at the station in time, board the train. All these actions of mine were *purposive;* and they were all directed toward catching the train; without that purpose, my actions during that same period would have been wholly other; if someone asked me for instance why I was riding in the bus, I should tell him that I wanted to make the 8:10 train. The answer would be satisfactory; he would *understand.*

With Aristotle, the Scholastics made much of purpose. They first defined it as that for the sake of which or on account of which something is done. Then they numbered it among the causes, calling it the *final cause.* Rightly. In the example given, did not the purpose of catching the train make me do things which I would not have done otherwise? And does not purpose explain these actions of mine satisfactorily? Lastly, the Scholastics laid down the axiom: *All activity* is purposive (quidquid agit, propter finem agit). The axiom was meant to cover the whole range of being, and was extended to every kind of activity.

From all this the Scholastics drew a new argument for the universality of order. Because the ultimate end of all activity is God's own glory, there is universal order. The proximate end of created activity might be one in a million; but no matter what it is, it necessarily contributes to the ultimate end, and so we have order everywhere.

2. PURPOSE IN NATURE

Without falling into the error of anthropomorphism, we confidently assert the *existence* of purpose in plants and animals. Examples are plentiful, and many are gathered in Janet "Final Causes" p. 51-84. If space allowed, I should quote the whole article which appeared in the *Catholic*

World of Oct. 1935, entitled "Go to the Fly, Thou Skeptic". The author, E. J. Anderson, made a most minute study of the ordinary housefly and, looking at that unpretentious animal from every angle, finds such manifest purposiveness in all its anatomical features that he thinks only a skeptic could deny its presence.

We need not delay on the objections urged against assuming purpose in the things of nature. Relics, for the most part, of 18th century cynicism or 19th century materialism, they can be and have been answered effectively.[1]

More widespread, one might almost say universal, is the practice of ignoring purpose in nature. Descartes thought it "presumptuous for us mortals" to try to comprehend God's designs, since His liberty is absolute and infinite. Bacon numbered the investigation of final causes among his "idols", calling it idolum tribus, and granting value only to the study of efficient causes. "The habit of seeking final causes in physics", he writes, "has expelled and, as it were, banished from it the physical causes. . . . All explanations of this kind are like those of the sea-lampreys which, as certain navigators have imagined, fasten upon vessels and stop them. . . . They have caused the investigation of physical causes to be long neglected" (De dim. et augm. scient. III 4). P. Janet rightly notes: "From this objection of Bacon is dated and has originated the war which men of science since then have not ceased to wage against final causes" (p. 180).

A. D. Ritchie, lecturer in biological chemistry in the Victorian University of Manchester, even pretends to be at a loss to know how a question can be put concerning the purpose of things, or how purpose can explain anything. He writes (p. 183): "If any man of science set himself

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[1]Cf. Janet p. 179-247; Lahr I p. 622-4; Gerard p. 89-97.

to try and answer questions about purpose as well as the other sort (of causes), there seems to be no harm in it"; but he adds: "The scientific study of living things does not for the most part depend for its progress on our ability to answer questions about purpose. . . . It is hard to see what is attained by either asserting or denying such 'explanations' ".

But a brighter day is dawning. Luther Burbank, though a staunch admirer of Darwin and his purely mechanistic principles of evolution, yet ascribed the growth of spines on cactus to a definite purpose. Study of purpose in nature is advocated by A. Wolf in "Essentials of Scientific Method" (p. 124): "In the study of certain biological phenomena, and above all in the study of human experiences and activities, individual and social, it is scarcely possible to dispense with the conception of purpose, if we are to have really adequate explanations". Speaking of migratory birds, Thomson's "Outline of Science" remarks (p. 428): "Migration must serve some good purpose and be of advantage to the species which possess the habit".

The writer of the chapter is clear-sighted enough, however, to warn his readers "not to fall into the trap of imagining birds as endowed with human knowledge and intellect—with the power of adopting a reasoned course of conduct based on the foreknowledge of seasonal events and on an appreciation of geographical differences". Would that all writers took this advice to heart, and ceased to endow plants and animals with human intelligence. Not only is such a practice fantastic, but the fact is that no purely human intelligence could excogitate those courses of conduct. Purpose in nature calls for *superhuman* intelligence. While we understand it to some extent post factum, who of us pretends that his wisdom would have been adequate to devise it and build up the present order out of chaos?

For this reason, anthropomorphisms should not be indulged in too freely, at least not in a scientific context. Yet an otherwise instructive article on the "Flower Pageant of the Middle West" in the *National Geographic Magazine* of August 1939 speaks of the "family pride" of the oak and other trees, of the "parental solicitude" of flowers, of the "social habits" of our deciduous trees etc. And the article is meant to be science, not poetry. N. Taylor, Curator of the Brooklyn Botanic Garden, manifests sounder judgment. He admits often using terms in his "Botany" which imply reasoning faculties; but he is level-headed enough to warn the reader: "Of course, plants are never reasoning things, reasonable as many of their actions appear to be, and to ascribe such qualities to them is to saddle them with attributes perfectly foreign to them".

The same argument applies to those who endow Nature, written capital, with this superhuman intelligence; for Nature is nothing apart from the individuals of nature; no over-soul ever existed except in the woolly brains of New England Transcendentalists.

While some evolutionists agree with us in admitting purpose in nature, yet when we look a little closer, we grow uneasy. Thus Sir J. A. Thomson, in the Introduction to "The Great Design," says (p. 15): "What Science seems to show is that we cannot make sense out of the Universe and our place in it unless we believe in the reality of Purpose". Splendid. But after reading his concluding chapter, we shall probably reverse our judgment. He there writes: "Most of the long process looks as if it were the evolution of a purpose—and part of this purpose is clear, namely, progress. When we envisage the evolutionary process as a whole, especially the way in which the primeval prepares the lines for the higher steps and makes them possible, we cannot get away from an interpretation in terms of Pur-

pose. Life not only grows, but it grows to some end. Otherwise there is no sense in the story. Especially when we open our eyes wide at the evolution in the light of Man, who is the patent outcome of it all, its flower and fulfilment". The two World Wars we have just gone through, have raised serious doubts in the minds of many whether this evolutionistic principle of continuous progress is really true or is merely the illegitimate brain child of modern optimists.

3. INTRINSIC AND EXTRINSIC PURPOSE

1. The Scholastics, when analyzing purpose in nature, almost invariably confine their outlook to anatomic structure, physiological functions, habits, instincts etc. Their main aim is to establish the existence of purpose in beings devoid of reason; and the purposiveness manifest in these things is so striking that only those do not see who wilfully shut their eyes.

But these are for the most part instances of what may be called *intrinsic* purpose (bonum sibi) ; it is good for birds to have wings, for fish to have fins, for cows to have a multiple stomach, and so on. These things benefit the possessors and them alone directly. Natural tendencies benefit the individual and the species. And so we understand why de Backer says succinctly (p. 28) : "Finis in quem plantae operationes tendunt, est conservatio tum individui tum speciei". Likewise, with regard to instincts in animals, Fr. Gaffney states: "All instincts, whatever particular action they promote, reductively make for the preservation of the individual and the preservation of the species. . . . This division dates back to Aristotle and represents an obvious cleavage". H. Gruender defines instincts (p. 241) as "complex activities of animals which are common to all individuals of

the same species, and by which the welfare of the individual and preservation of the species are secured".

But there is also *extrinsic* purpose or finality (bonum alteri). Plants and animals do things which do not directly or primarily benefit them or their species, but yet are necessary for the *household of nature*.

Let no one think that this is a novel idea. Aristotle said: "Nature makes only things fit for a purpose, and makes them fit for their several uses". In the passage cited earlier from De Genesi ad Manichaeos, St. Augustine evidently supposes that God created all things for an extrinsic purpose, that is, for the service they can render in the maintenance of the universe. This becomes clearer as we continue reading: "I must confess that I do not know why mice and frogs, flies and worms were created". Though he is sure that all things are beautiful in themselves inasmuch as all show forth measure and number and order in their parts, he confesses his ignorance concerning the extrinsic purpose of some creatures.

The idea of extrinsic purpose also underlies Suarez' solution of the question ("quaestiuncula") whether God created all species of plants on the third day (De opere sex dierum II 7). We must admit, he says, that God then created all species of trees, cereals and perfect vegetables; for these are necessary for man and beast, and God intended them per se and for that purpose. But, he asks himself, what about poisonous plants, weeds etc? He recalls that St. Augustine and others thought that these had not been created until after the fall of Adam; he also recalls the surmise of some that the rose was originally created without thorns. With St. Thomas, Suarez rejects both opinions. He holds that these plants, too, were created on the third day as we know them now; for they pertain to the perfection of the universe, and though harmful in some ways, are in other ways

beneficial and medicinal, "praesertim cum aliis mixtae et bene temperatae".—Soon after him, Linné expressed his conviction of the existence of extrinsic purpose in the following words: "Everything is created not only for its own sake, but also for others. . . . There is such marvelous order in the world . . . that everything must serve others".

Modern scholastic manuals of Ontology carry the thesis: Omne ens est bonum sibi et alteri. And supposing the existence of an all-wise Creator, Scholastics, like St. Augustine, find it easy to prove the thesis a priori. But F. H. Sweet was led by his painstaking study of birds quoted above (p. 146-150) to arrive at the same conclusion a posteriori. He writes: "It would almost seem as though each species (of birds) were intended to perform certain services in the economy of nature which could not be so well done by any other species. . . . Thus the swallow tribes are guardians of the atmosphere, which would otherwise swarm with immense quantities of minute insects; woodpeckers, creepers and chickadees are the guardians of the timber of the forest; sylvians and flycatchers of the foliage; blackbirds, thrushes, crows and larks are the protectors of the surface of the soil; and snipes and woodcocks, of the soil under the surface. Each family has its respective duty to perform, and it is man's loss if he disturbs the equilibrium by reducing the number of species below the supply of insects abounding".

Myron Gordon tells us in *The Aquarium* (Nov. 1942) that "ichthyologists collecting Guppies, noting their tremendous abundance in the fresh waters of Northern South America dubbed them 'millions fish' ". But then he points out their usefulness: "Their ability in withstanding polluted, stagnant waters have been pressed into service by public health officers in many tropical countries for the vital job of eradicating mosquito larvae". Would it be un-

scientific to see in this the extrinsic purpose of Guppies? Some years ago, a writer in the *Saturday Evening Post* put forward the statement that the shark is the scavenger of the seas. If it can be shown that this is indeed the purpose of shark, then there is such a thing as extrinsic purpose.[2]

2. Nevertheless, many modern writers fight shy of the idea that any living species exists for something beyond itself.

One of the contributors to Thomson's "Outline of Science" says: "Each species lives for itself; no species ever undertakes anything for the sake of another, except in the expectation of a corresponding advantage. If the wild thyme lays by in its throat abundant honey for the bee, that is because the bee carries its pollen from blossom to blossom". Besides indulging in anthropomorphism, this is making selfishness the ultimate guide of life.—The *Atlantic Monthly* of May 1931 brought an interesting article on the "History of the King Bee" by Charles D. Stewart, whom the Contributor's Column describes as "Wisconsin's natural philosopher". Though aware of the bee's life-purpose, he sidesteps it at the end of the article: "What a bee lives for, would be hard to say, looking at the thing from an individual and selfish standpoint. Like the rest of animated nature, vegetable as well as animal, bees are engaged in the work of propagation. And they seem to be wholly and heartily taken up with the work".—A. H. Clark, too, can discern nothing beyond the propagation of the species. He thus begins an article on "Who's Who among the Butterflies" (*National Geographic Magazine*, May 1936): "Butterflies seem care-

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[2]Cf. Coffey, *Ontology* p. 405-6, 409-410. However, intrinsic and extrinsic purpose (finality) may also be taken in another sense, viz. according as the tendency toward an object springs from the nature of the thing or is impressed on it by an external impulse. Cf. Coffey ib. p. 426.

free creatures, but they have a special duty to perform. That duty is to produce eggs and scatter them far and wide on the proper food plants so as to insure the largest possible crop of baby butterflies, or caterpillars. All their efforts, all their emotions—and they are many and diverse—have to do with the proper performance of this duty".

Would it not be a funny world if these writers had had the ordering of it?

3. We must go one step further.

The extrinsic purpose of plants and animals is not something superadded, something secondary to their nature as P. Coffey (Ont. p. 406) and P. J. Glenn (p. 286) assert; it is their very raison d'être. Their nature is such and must be such as it is because they are intended for this purpose; their extrinsic purpose is the principal reason for their existence, *the most fundamental trait of their being.* Plants and animals would not have been created if it had not been for their extrinsic purpose. After all, things do not exist for the mere sake of existing, nor do living things exist merely to enjoy life, be it their own or that of the colony or of the species. It is not true to say, as does Frank (p. 89), that "organisms attain no other object than self-preservation or increase in number by the reproduction of like beings".[3] All things are *dynamic*. They have a function to fulfil. They are meant to accomplish some definite work in the household of nature, and this is done by some external activity directed toward an extrinsic purpose.

A Bible Christian may object to such a thesis that it is in defiance of what Christ says: "Look at the birds of the sky, how they neither sow nor reap nor gather into barns. . . . Observe the lilies of the field, how they grow; they neither

[3]In a footnote on p. 93 Fr. Frank mentions the distinction between the "inner i.e. inherent" and external purpose, but says nothing further about it.

toil nor spin" (Mt 6:26-8). Do these words not imply that neither plants nor animals, at least not all plants and animals, are made for work?

Certainly not. To read that meaning into Christ's words would be a ludicrous misinterpretation. His aim was not to teach His hearers botany or zoology, but to awaken in them a lively faith in divine Providence, in the all-knowing love of the heavenly Father. To the Palestinian farmer, who toiled from morning till night to eke out a scanty living, the birds of the sky and the lilies of the field seemed to be thriving without work. Christ accommodated Himself to their way of looking at such things, using a beautiful comparison to drive home a most consoling, yet much-needed lesson.

4. One acquainted with scholastic philosophy might ask: Is this extrinsic purpose the *finis operis* of plants and animals or their *finis operantis?*

As this distinction is hardly familiar to the readers of this essay, yet important for a right understanding of our thesis, let me explain it briefly.

Take your grandfather's clock. If asked what was its purpose, you would say: To indicate time. Yes, but was that also the reason which moved the clockmaker to ply his trade? Perhaps. But more likely the reason why he constructed clocks, was to make a living. He might have achieved the same end by turning out flintlocks or spinning wheels or mousetraps. Possibly, too, making clocks was merely his hobby or pastime. Indicating time then is the *work's end* (finis operis), the purpose which every clock has that pretends to be a clock; but making money or enjoying oneself would be the *worker's end* (finis operantis). The two may be identical; they may also be distinct.[4]

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[4]Coffey, *Ont.* p. 410; Cotter, ABC etc. p. 401.

If we now apply the distinction to our subject, we must say that the extrinsic purpose of plants and animals is their *finis operis.* As the finis operis of the clock is to indicate time, so that of the cow is to produce milk, of the sheep to furnish wool, of the bees to make honey, and so on. And as all parts of the clock are subordinated to its finis operis, so likewise in plants and animals. Consequently, as the parts of a clock can be fully understood only in their subordination to the prime end, so likewise the parts of plants and animals.

What then shall we say of the *finis operantis?* God created plants and animals. What for? Proximately for man; for, as we saw, all the realms of nature exist for man's benefit. If it were not for man, God would not have created this world. Ultimately, however, God created all things, man included, to manifest His own goodness. And since plants and animals contribute to that by their very finis operis, in their case the finis operis and the finis operantis are identical—just as the two purposes are identical in the case of the clock which the horologist makes for his own use.

CHAPTER 18

Definition of Species

Nothing now remains but to draw the conclusion, and we have the answer to the problem which we set out to solve in this essay, viz. the essential definition of biological species. We shall first lay down our definition, then compare it with the traditional definitions contained in manuals of botany and zoology, and finally meet some objections that might be urged against it.

1. OUR DEFINITION

1. In accordance with the preceding chapter, a biological species is a group of living organisms created for the *same purposive activity*, meaning by the last term *extrinsic* purpose. Consequently, two groups of living organisms differ specifically or constitute two natural species if their purposive activity is not the same. Or if we take the second meaning of "species", we shall say that a species is a living organism (plant or animal) with such and such purposive activity.

If this is the metaphysical essence of species, we can easily deduce the physical. According to scholastic philosophy, all living organisms consist of two parts, two incomplete substances: body and soul. Plants differ from animals in the make-up of their bodies, but primarily in the nature of their souls. The plant soul imparts to the plant purely vegetative life, whereas the animal soul endows the animal with sense life joined to vegetative life. Hence Scholastics define the plant as a being or a substance consisting of a body and a purely vegetative soul, and the animal as a substance consisting of a body and a sensitive soul

(the sensitive soul necessarily implying the power of vegetation).

These are generic definitions. For a specific definition, the vegetative or sensitive soul would have to be modified by an addition expressing the extrinsic purpose of that species of plant or animal. For instance, the bee is a being consisting of a body and a sensitive soul with the natural tendency (power, faculty, function) to manufacture honey.

2. For proof of our definition nothing more is needed than what was said in the last chapter. But it is interesting to note that the Scholastics, analyzing the relation between activity, purpose and species, arrived at the same definition without benefit of science. St. Thomas enunciated it in a form consonant with medieval thought: "As matter is for the sake of form, so the form is for the sake of its specific action; for action is the purpose of creation" (Summa theol. I qu. 105 a. 5). Suarez was even more explicit: "The purpose of the substantial form constitutes and completes the essence of the natural being. Such purposiveness is necessary, because without it no body would be complete and perfect in its substantial nature, nor would there be such a multitude and variety of species, in which the marvelous disposition and beauty of the universe mainly consists" (Disp. Met. D 15 s. 1 n. 18).

But there are some *advantages* which greatly recommend this new definition.

a. One is that it gives us the ultimate reason for the best *criteria of species.*

If nature wants definite results, and if definite species of organisms are created to insure them, nature must take care that they are kept going, but so that they will remain unchanged in succeeding generations. If cow's milk is called for in the household of nature, nature must provide living conditions for thoroughbreds and discourage hybrids; else

the supply of milk may cease altogether or the milk be adulterated at its very source. And so we see the necessity of indefinite fertility and mutual sterility, our first criterion of species.—Again, identity of equipment is necessary for organisms which have the same work to do; different equipment is called for where the work is different. Thus animals that are meant to catch insects on the wing, evidently need different equipment from those whose purpose is to destroy grubs under the soil. This gives us a clue to the criterion of marked gaps.—The necessity of the sixth and seventh criteria is perhaps less apparent. But since nature does not work with miracles, there must be a definite sequence of stages through which an individual passes to reach maturity and to become capable of doing the work mapped out for the species by nature. And since the very first stage of this evolution consists in the redistribution of the chromosomes, we can see to some extent why the number of chromosomes must be definite for each species.—Lastly, the necessity of specific instincts is only too manifest. Nature must implant in all individuals of an animal species a liking for the job assigned to them, an impulse and urge so compelling that only death can circumvent its fulfilment.

b. Another advantage of our definition is that it gives us that *virtually complete knowledge* implied in the general definition of species, which is "complete essence". An example will illustrate it.

Take a human artefact, the speedometer. A speedometer is a mechanism whose purpose is to indicate the speed of a vehicle. That is its complete essence. A speedometer differs essentially from a clock, for instance, which is also a mechanism, but whose purpose is to indicate time. The two are non-interchangeable; one will never do for both purposes, and hence the panel on our car contains both.

Now the novice driver need not know how the speedometer works, though if he is interested, any garage mechanic will tell him. But knowledge of the purpose will furnish him with the ultimate clue to all the wires and wheels and rods which are connected with the dial. That purpose makes him understand all. His knowledge of the speedometer is virtually complete.

c. We may cite a third advantage of our definition.

Paleontology assures us that not all species of plants and animals originated at one and the same time, and that some species are now extinct. Our definition renders both facts intelligible. It may well have been that in distant geological ages certain kinds of work were not necessary in the household of nature which are necessary now, or that certain work had then to be done for which there is no need now. Species originated as the need for them arose; when a species became superfluous, it was allowed to disappear.

How nature brought about the death of these species, is a question which does not pertain here. The simplest method was to alter conditions so that such species could no longer live, as the advancing ice cap seems to have liquidated the mammoth.[1]

2. TRADITIONAL DEFINITIONS

What now shall we say of the features which naturalists have stressed hitherto, and on which their descriptions of plant and animal species are built? For, as is well known, naturalists, to define species, enlarge on the size and color of the body and its different parts; they count the rings of the lobster, the feet of the caterpillar, the wings of the insect; they study the nests of birds and the holes of foxes;

[1]Cuvier excogitated the theory of catastrophes or deluges, which has few adherents today. Cf. Murray p. 349; Beraza p. 169-172; Lyell II p. 268; ch. 42; O'Toole p. 67-69; Monaco p. 224.

they peep into the womb of life and mark off the various stages of animal evolution. Anatomy, physiology, the analogy and homology of organs, cytology, embryology—all are consulted to define species of living organisms. Our definition says nothing of all these things. Do they then mean nothing? Have naturalists labored in vain since the days of Ray and Linné?

Not at all. These traits, too, have their meaning and importance, but on condition that they are inserted in the right place. They are the tools with which nature has equipped plants and animals for their work; they are the internal complement of their extrinsic purpose. The anatomical structure of the lion is such as manuals of zoology describe it, partly because such are the physiological functions of the beast, partly because such are his means of locomotion, partly because such are the defensive and offensive weapons which he needs to survive in the struggle for life. So far the traditional descriptions of the lion help us to understand him. But the features mentioned are all *subordinate* to the extrinsic purpose for which the lion was created, and to the specific activity by which he attains it. As long as these are hidden from our eyes, we are apt to err in the interpretation of the single features; as long as these are ignored, the definitions of naturalists will remain mere descriptions. A Scholastic therefore would admit only sensu aiente what Chidester says on page 1: "In order to understand an animal thoroughly, we must know its anatomy, physiology, reaction to environmental conditions, and its economic importance". He would deny that such knowledge suffices. It would be like knowing the various rods and wheels of the speedometer without knowing its purpose.

This explanation of the relation between morphology etc. and essence is by no means new. It was hinted at by Aristotle more than once. "Aristotle rightly argues," says

Suarez (Disp. Met. D 23 s. 10 n. 7), "that the last reason why things of nature have such characteristics or such organs or such parts etc., is not due to matter, but to their purpose. . . . They were given for some purpose or form, and the form needs them for self-preservation or some activity". In his Summa theologica (I II qu. 102 a. 1), St. Thomas expresses the same idea, though in a totally different context (ceremonies of the Old Law): "What is for a purpose, is *proportioned* to it; and therefore the reason of whatever is for a purpose, is taken from this very purpose—just as the reason why the saw is made so, is taken from cutting, which is its purpose".

On the other hand, we now see why the three criteria of species taken from morphology etc. are so unsatisfactory. Likeness, unlikeness, constancy of characters are very well and good if we know which of them are essential. The complete essence is the sum-total of those marks by which we fully understand why a thing *must be so* and cannot be otherwise. Now the connection between man's essence, for instance, and his peculiar anatomy or even his physiology is not so univocal in all its details that we must infer the former from the latter. To pick out but a few items. Why is it that we have two legs? Why are we not quadrupeds or centipedes? Would man no longer be man if he walked on all fours? Or why must we have 5 fingers on each hand and 5 toes on each foot? There have been, and presumably still are, persons with a supernumerary finger or toe; yet they are not counted as a new species of man.

The application to the matter in hand is easy. It may be practical to identify different species of trees by their leaves. But leaves give us no insight into the specific nature of trees. Who can tell, for instance, why the pin oak or the ash or the maple must have this particular kind of leaves? Classification by such features is at most systematic, not natural.

3. OBJECTIONS ANSWERED

Unlike Scholastics, modern writers are not in the habit of facing actual or possible objections against their theories. It is the reader's loss. For nothing is so reassuring as when objections are stated fairly and then shown to be groundless or reconcilable with the writer's contention. To put my readers at their ease then, I ask myself: What are the objections that have been or could be urged against the proposed definition of biological species?

1. One objection might be formulated thus: A definition is supposed to contain the essence of things, and the essence is the most *intrinsic* trait possible; now extrinsic purpose, as the adjective indicates, is something outside the thing to be defined. Therefore the extrinsic purpose of organisms cannot give us their essence or definition.

The answer to this objection lies in the identity of the finis operis and the finis operantis. The objection would have some force if the two were distinct. But living organisms must be such as they are because of the work they are meant to accomplish. Therefore their extrinsic purpose leads us to their very essence.

2. Not much different is P. Janet's argument (p. 184): "I can affirm nothing with exactness regarding external finality, because it is not written in the *constitution* of the being itself".

Janet really tries to answer Descartes' objection to the study of purpose in general. He distinguishes. He insists that we can know the intrinsic purpose of things and also their extrinsic purpose in general; but he denies that we can know the *specific* extrinsic purpose, and he quotes Gassendi and R. Boyle to the same effect.

Janet's distinction is imaginary. Like the generic or general, the specific extrinsic purpose of plants and animals

is written in their specific constitution; for they are what they are because of it. The purpose is called extrinsic, not because plants and animals are pushed to it by an external force (as the football is driven toward the goal), but because the object to be attained is outside of them. The impulse to attain the object is planted in their very nature.

3. This would seem to be the place to examine Sortais' three obstacles against any satisfactory definition of species (supra p. 48): insufficient observation, impossibility of experimentation, the flexibility of nature.

Now it is difficult to see why no amount of observation should be enough to state definitely: This is the extrinsic purpose of this animal or plant. Nor is all experimentation excluded in this domain. Why cannot the researchist vary the ordinary conditions under which animals operate, confront them with new situations, vary their diet etc.? As regards the flexibility of living organisms, we must remember that while these are less rigid in their behavior than inorganic substances, there is a limit beyond which they do not vary.

4. A Scholastic might argue thus: *Man's definition* is admittedly "rational animal". Yet, though meant to convey the complete essence of man, it says nothing about his extrinsic purpose. Why then should extrinsic purpose constitute the complete essence of plants and animals?

The answer to this objection has already been given in part. Man, being the lord of creation, does not belong to the balance of nature. Nature is meant to serve him, directly or indirectly; but he is not made for it, either directly or indirectly. The balance of nature would in no wise be disturbed if man disappeared from the face of the earth—just as the rise and fall of the tides would go on if no ship sailed the seven seas.

Besides, man's primary purpose does not lie in external

activity. External activity is less essential to man. Man is primarily a thinking being, made for speculation and meditation. In fact, these internal activities of the soul are the crown of his work, and without them his external works are of little value. Plants and animals, on the contrary, neither speculate nor meditate; for they lack the power of reflection necessary for both. Their purpose is eminently *practical.* They would not have been created if it had not been for the work necessary to keep the cosmic order a going concern.

One might, however, continue the argument and say: Scholastics also define *plants and animals in general* without falling back on extrinsic purpose, and their definitions are accepted widely.

This argument cannot be met in the same way. But these definitions are *relative,* inasmuch as in them plants and animals are compared to man. Since external activity is not primary to man, it was also disregarded by the Scholastics when they looked for a generic definition of plants and animals.

Yet there would be nothing illogical about inserting extrinsic purpose in the generic definitions. Only then the primary division between flora and fauna would be spontaneous motion rather than sense life (supra p. 12-13). But this would not constitute a serious break with the past. Because plants can do the work allotted to them without locomotion, they need no sense life; because animals, to accomplish their purpose in nature, must perceive and move toward distant objects, they are endowed with senses.

The motility with which certain plants are endowed, presents no formidable objection. Their motions are not directed toward a *definite* object, but carry the organism along blindly until it meets with a suitable object. And of those organisms which move about freely in their early stages,

but become fixed when mature, we are not sure whether they are really plants or animals.

5. A friend of mine asked me what else animals do except eat and multiply. He meant to say that these two activities take up the whole of an animal's day, and that therefore *no time is left* for work at an imaginary extrinsic purpose. Myron Gordon, too, says (l.c.) that the normal activities of the male Guppy are "courting and seeking food, usually in that order, in the business of the Guppy-day"; no sign of purposive activity.

The answer, however, is fairly simple. By their normal activities, animals accomplish the work prescribed for them by nature. Guppies, by feeding on mosquito larvae, purify stagnant waters; bears, by looking for ant honey to feed on, break down tree stumps and so return their matter to the soil more quickly; earthworms, by hunting for grub under the soil, aerate the soil etc. We must not compare animals with men, in whom activity useful to others is distinct from taking three square meals a day.

6. The last objection may be put in the form of a question: Why must there be a *common* definition of biological species? Was Prof. Kerr really wrong when he chided Darwin for "fostering the idea of 'species' being equivalent throughout the realm of living nature" (supra p. 32)? Would it be absurd to say that the definition should vary at least with the kingdom—one for plants, another for animals?

No, it would not be absurd. But because both plants and animals have their raison d'être in the balance of nature, because the balance of nature rests on the continuous cooperation of both—it seems that the ultimate idea of species should be the same for both kingdoms.

CHAPTER 19

A New Method

This title sounds perhaps more ambitious than the chapter will prove to be. The method here recommended is really nothing new; it is induction, well-known to scientists and analyzed in an earlier chapter. What is comparatively new, is an answer to two questions.

a. One who sets out to establish a universal proposition by means of induction, must face the question: *What should be observed?* For the indispensable basis of induction is observation. But since observation has for its object individuals, and since in every individual attention may be directed to various features—it is of prime importance to know, at least in a general way, what observations will lead to the definition of particular species.

b. The second question, though perhaps less important, is worth while discussing: *Who* is to do the spade-work? Who is to make the necessary observations? The scientist or the philosopher? Arguments have been bandied between them, and both like to "pass the buck".

The present chapter then will be divided into two parts: rules of research and the researchist.

1. RULES OF RESEARCH

The following 6 rules would seem to be the most practical.

1. The easiest and at the same time the most logical beginning would be to *stake off* the territory by means of the several criteria of species. As external marks, they are quite sufficient to distinguish species from species. They tell us nothing or not much about the essences of plants and animals; but they enable the naturalist to establish lowest

natural groups, and he can thus narrow his field of observation, which would otherwise be vague and ill-defined.

Actually, naturalists aim at such a procedure. Each picks a definite group of plants or animals for his object of research.[1] But they do not at once determine the chosen group as a natural, not merely a systematic species. One wonders why. There is no a priori reason why this could not be the first step of the systematist.

2. A qualification which is much neglected in modern practice, but which is yet necessary for arriving at a true definition of species, is the ability to widen one's outlook to the *individual as a whole.*

Botany and zoology are today broken up into a number of sciences, or rather each of the biological sciences considers only a part of the organism studied. Cytology merely studies the structure and behavior of the cell; genetics restricts itself to genes and their influence on the body; anatomy is content with dissecting the cadaver etc. Everyone today is a specialist or he is nothing. Good—within limits, that is, if such an attitude does not make us forget that the individual exists in its own right, that it is prior to and bigger than all its parts, and that therefore there can be and should be a science devoted to the individual as a whole.

The need for a change of heart has recently been adverted to in other quarters. In his Textbook of Logic (p. 143), A. Wolf insists on it: "The history of botany is, to a large extent, the history of various attempts to classify plants on the basis of all kinds of attributes, such as the character of the leaves, of the fruit, or of the corolla, of the calyx, or of the stamens. What is sought after in natural classifications, especially in biology, is that the things

[1]Cf. E. Mayr p. 12.

as a whole should be taken into account". Likewise, Parker and Haswell, in the introduction to their "Manual of Zoology", enumerate the various viewpoints which scientists have adopted for the classification of animals. But then they continue: "As it is impossible to have a right understanding of a machine without knowing something of the purpose it is intended to serve, so the morphological study is imperfect without some knowledge of its physiology, i.e. the functions performed by its various parts, and the way in which they work together for the welfare of the whole. Not only may we study the actions of a given animal's organs, but also the actions of the animal as a whole, its habits, its relation to other animals (whether as friends, as enemies or prey), to the vegetable kingdom and to its physical surroundings". And Prof. Dwight merely repeats what the Scholastics had been saying right along: "Surely it takes no great talent to see that to place any being correctly in the scale of creation (or if you prefer in that of nature), it is necessary to study and classify him as a whole" (p. 157).

From all of which it follows that to the systematist all biological sciences (anatomy, biology, cytology, embryology, genetics, biochemistry, organic chemistry etc.) can only be *subsidiary*. They have their value and importance; but the formal object of each differs from the one that will lead to the definition of natural species. It also follows that definitions of species based exclusively on any of these sciences are only systematic, and that they may vary (as they do) according to the particular science on which they are based.[2]

3. But this demand seems to lead into a blind alley.

Scholastics called the individual "ineffable", because each individual has a million facets, and no amount of observa-

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[2]This is recognized by B. D. Jackson, Glossary of Botanical Terms.

tion can ever hope to exhaust them all. It is for this reason that every science restricts itself to one particular aspect, which Scholastics call the *formal object.* Is it possible then to take the individual as a whole and yet pick out a formal object for the systematist? Which of the million facets of the individual should occupy him who aims at a definition of natural species?

We know the answer. The principal feature to be observed is *external activity.* As Fabre once slyly remarked about a newly-found beetle whose name was disputed among entomologists: "Instead of asking the animal what its name is, let us begin by asking: What can you do? What is your business?"

But how can we find out what is an animal's business?

Let us take the shark. A little while back, a writer was quoted as claiming that the shark is the scavenger of the seas. Very illuminating, if true. But listen how he proceeds to prove his assertion: "The shark is usually found hovering near the slaughter-house drains. He invariably follows fishing craft homeward bound, to gather fish refuse cast overboard. He always lies close to a vessel in port, waiting for the ship's garbage. The shark is sought with dead bait; he is wary of live bait. . . . It may be safely stated that unless a shark is ravenously hungry, he will not attack a human being, unless he is positive that the man is drowned or is absolutely helpless".

Is there sufficient warrant for all these assertions? That is another question which may be left to experts. Dr. Heiser, for instance, claims (p. 393) that he has treated patients whose legs were bitten off by sharks. Besides, there are sharks and sharks; the basking shark, the blue shark, the hammerhead etc. Are all of them scavengers? Webster states that most sharks are destructive of other fishes, and that the larger ones are often dangerous to man. Be that

as it may. The example illustrates the *kind of evidence* that would manifest external purpose. It also illustrates the necessity of *hypotheses*. To observe the facts, be it done ever so accurately, is not enough. The systematist must group them tentatively, and then set about to prove or disprove his own grouping.

4. After the preceding it is almost superfluous to say that specimens should be studied *when alive and as alive*. "Viventibus vivere est esse", wisely said the Scholastics; a living being is nothing unless it lives. How preposterous then to chloroform or kill a beetle to learn its nature. A dead beetle is something essentially different from a live one. J. St. Mill, quoting Comte, rightly says: "It would be absurd that we should not be able to determine the genus and species of an animal without first killing it". And Sir A. E. Shipley remarks: "The dead dogfish in a dissecting dish gives one but little idea of what it did and what happened to it when it was alive". Or have we come to such a pass that biology must be defined as the science of corpses? But such was evidently Audubon's idea, who first shot and killed the eagle and then tried to prove it a new species.

No doubt it is easier to capture your frog, kill him with a deft stroke, and then describe leisurely his color, size, the number of ribs, and so on, than to sit for hours by a mosquito-infested pond and watch him at his daily chores. But surely, science is not wont to follow the line of least resistance.—No doubt, too, the method here criticized bears the sacred stamp of antiquity; no less a scholar than Linné inaugurated it, and a long line of naturalists have practiced it to this day. But what is the result? The very concept of natural species is in danger of disappearing from botany and zoology.

The urgency of a radical change has been noted elsewhere. In the same number of the *Catholic World* (Oct. 1925),

B. C. A. Windle and E. G. Reinhard came out for a saner method. The former insists that "living things should be studied as alive and not as museum specimens, if we are really to understand their meaning and relations" (p. 72). The latter asks with Fabre: "Is the life of a wasp so devoid of interest that attention should be centered on the dead cadaver"? (p. 87). Long before, Fabre had voiced a similar complaint: "When shall we have an entomological laboratory for the study not of the dead insect, steeped in alcohol, but of the living insect; a laboratory having for its object the instincts, habits, the manners of living, the work, struggles, the propagation of that little world with which agriculture and philosophy have most seriously to reckon" (Wonders of Instinct p. 14)?

If these suggestions were taken to heart, then even the layman could enjoy the fruit of scientific study. How dull and dry and dead appear the anatomical descriptions of the eagle in our manuals of zoology and encyclopedias when compared with "The Eagle in Action", an article written for the *National Geographic Magazine* (May 1929) by H. F. Herrick. As the subtitle says, it is an account of an intimate study, based on Hollywood methods, of the homelife of eagles in Ohio. But above all, it gives us action and life, not a carcass.

5. That the primary object of this fresh-air study should be the *mature individual*, is too plain to call for amplification. Only the full-grown individual has the full use of the natural powers of the species and can do the work assigned to the species by nature. Applied to animals, this means that the naturalist is to observe the *specific instincts.*

Unfortunately, the instincts commonly treated in our scientific and philosophical works refer only to intrinsic purpose. This is clear enough in the case of the instinct for food, the play instinct, the instinct for self-preservation.

But even the instinct for propagation and for the care of progeny, of which we spoke in ch. 9, serves directly only the continued existence of the species. They are good criteria of species, but they tell us nothing about the essence of the species. What we are looking for are instincts which drive animals to do a *definite work in the household of nature,* to perform definite tasks, such as are described in Mr. Sweet's article (supra p. 146-150). It is these that will give us insight into the extrinsic purpose of animal species and thus into their essences.

6. The last rule that must guide the researchist, is an application of L. Agassiz' slogan: Study nature, not books. Living beings should, as far as possible, be studied in their *natural state and habitat.*

Mrs. Delia J. Akely, who spent years in the great forests of Africa studying the habits of monkeys, registers a bitter complaint (*Saturday Evening Post,* Sept. 18, 1926): "The real truth concerning the habits and characteristics of monkeys and apes can be learned only through exhaustive study. Years must be spent by the student in the lonely forests where the animals live. No caged animal or stuffed museum specimen with distorted bodies and horrid glass eyes can tell us the fascinating life histories of the wild free creatures. It is greatly to be regretted that much of our information about these interesting animals has been gained by deduction, travelers' tales, and by studying captive animals that live unnatural lives in cages and on man-selected diet".

What this rule entails, is well described by Fr. J. A. O'Brien, who gives us an inspiring account of Fabre's daily work (*Ecclesiastical Review,* Nov. 1943): "He made the fields and woods his laboratory. On hands and knees, he would spend hours under the scorching sun following the movements of ants in the grass, watching the maneuvers

of beetles in the field, studying the behavior of wasps in the burrows. From sun-up to sun-set, he would follow the movements of the insect he was studying until he could chart its way of life with an accuracy which had never previously been achieved. . . . He would go out into the dawn to watch the resurrection of the silkworm in order not to lose the moment when the nymph bursts her swaddling bands. By night he studied the Cione constructing a capsule of goldbeater's skin or the processional caterpillars moving head to tail along their path. 'My heart', he said, 'beats with emotion as I watch my little subjects, ferret out their secrets, and pass hours of oblivion in the happiness of learning' ".

2. THE RESEARCHIST

The second question is rather personal: Who should shoulder the research work, the scientist or the philosopher?

1. J. S. Moore (*Science,* Sept. 6, 1927) would throw the entire burden on the shoulders of the philosopher. For, he argues, the scientist "sets forth as his ideal the explanation, or at least correlation, of facts in terms of the all-comprehensive principle of causality, and in exclusion of ends or purposes". When Sir James Jeans, the renowned British astronomer, paid us a flying visit in 1931, and on his arrival was asked by reporters whether the universe bore evidence of design, he answered: "It is not the job of scientists to speculate on design; if there is design, it will come out in time". Sir J. A. Thomson says in the Introduction to "The Great Design" (p. 15): "Thoughtful men have continued for many centuries asking whether there is purpose in Evolution. This is one of the questions which Science neither asks nor answers".

Science then refuses to lend a hand in the search for the purpose of things. One might justify such refusal on philo-

sophical grounds. Philosophy, not science, searches out the ultimate causes of things. Now purpose is something ultimate. Language itself bears witness to this. End and purpose may be used synonymously in English; in Latin the same word "finis" denotes both; so does the French "fin" and the Greek "telos". The Scholastics themselves, when analyzing the notion of purpose, came to the conclusion that purpose is the last link in the chain of causes, and that all the other causes depend on it.

2. But there is purpose and purpose. Every purpose is a cause, but not every purpose is an absolutely ultimate cause. Purpose may be proximate, intermediary, ultimate. Now philosophers push to the ultimate purpose of all things of nature in globo, proving it to be God's glory. They also prove that the intermediary purpose of creation is man, directly or indirectly. But they stop short at the *proximate purpose* of things. That would seem to belong to science. First, science in general, as distinct from philosophy, investigates the proximate causes of things; now some purposes are proximate causes. Second, while philosophy rather relies on deduction, the method admittedly proper to science is *observation and induction;* now the proximate purpose of the things of nature can only be known through the latter method.

The conclusion seems then to be justified that it is for scientists to undertake the research for the purpose of organisms.

Perhaps some scientist may try to cut the ground from under this argument by saying that biology and the cognate sciences do study the proximate purpose of things. But the answer is easy. They study the intrinsic purpose of some parts of the organisms, but not the *extrinsic* purpose of the living and acting individual. That is to say: Not yet. The aim of this essay is to hasten the day when a

researchist will consider the extrinsic purpose of plants and animals a fit subject for special study, perhaps for a doctorate thesis or a monograph. At any rate, if scientists do not regard the study of the intrinsic purpose of organisms beyond their scope (and they certainly do not), then they cannot raise a fundamental objection against extending their research to extrinsic purpose.

3. As we saw in an earlier chapter, *Scholastics* felt hampered in the philosophical study of organic nature by the lack of reliable scientific data. They were not primarily scientists. To make general assertions about organic nature which transcended every-day experience, they were bound to rely on the data gathered by others, the naturalists, and naturalists refused to bother with purpose. One might ask: Why, under the circumstances, did they not turn naturalists to gain a more solid foundation for their philosophical speculations? Or why did later Scholastics neglect what a more intense study of nature in all its phases had provided?

The answer is not merely human inertia, but above all the Reformation and the subsequent rise of rationalism with the interminable controversies resulting from them. Scholastics of the last centuries might have preferred the work of the trowel, but circumstances obliged them to wield the sword against those who attacked the Catholic Church on all sides. Unlike Albert the Great or Roger Bacon in their peaceful medieval cloisters, the latter-day Scholastics had little time left to become specialists in nature study.

CONCLUSION

Whoever undertakes the research necessary for the definition of a biological species, should be conscious from the beginning that the task is not easy. First of all, the physical difficulties involved in this kind of work must be apparent. Secondly, the researchist will often enough be at a loss

to decide whether some activity is really characteristic and specific, or what purpose is involved in this or that kind of activity. Also, the facts of the balance of nature will at times oblige him to make a dubious choice between primary and secondary, generic and specific purpose. The principle of the economy of nature will force him not to overlook the various stages of evolving life. While the general rule holds that his first object should be the full-grown individual, yet extrinsic purpose is manifest, to some degree, in the earlier stages of some species. Seeds, eggs, fish-roe, caterpillars etc. also have their purpose in nature, if only to serve as food for other species.

And after the researchist has established the definition to his own satisfaction, there remains the practical difficulty of proving to other workers in the same field that the new species is a good species, not a mere hybrid or individual variant; also that it is not a genus or one of the higher categories, of which we shall speak presently.

Nevertheless, the examples given are evidence that the investigation of extrinsic purpose is highly interesting and can become fascinating. Nor is it purely speculative, as is clear from the necessity of keeping the balance of nature intact.

CHAPTER 20

Classification

I might have closed this essay with the preceding chapter. It was not my intention to work out definitions of the myriads of natural species into which the flora and fauna of this globe are broken up. Like Francis Bacon, I am content to be the bugler who sounds the charge and then withdraws to the rear of the regiment.

Yet our investigation would surely be incomplete if we stopped here. Species, as all admit, are differentiated on the one hand from varieties, on the other from *genera*. Varieties, being infra-species, do not differ essentially among themselves; a genus, however, differs from its species by not containing the complete essence. Genera, while giving us incomplete essences, have this advantage that they cover a wider area than species. Thus while the genus oak (Quercus) omits all differences between its 200 species, it contains the essence of all oaks whatsoever.

So far we have been occupied, almost exclusively, with the difference between species and varieties. It is time to ask if the thousands of natural species in both kingdoms of life are all on a dead level, or if they can be combined into higher and wider classes, called genera.

This is meant by the problem of *scientific classification* in its fullest sense. We shall devote to it chapters 20-24.

In this first chapter, we shall consider the abstract pattern of scientific classification as drawn up by the Scholastics and generally known as predicamental tree or Tree of Porphyry. We shall first study the meaning of such "trees", then the method of constructing them, and finally their objective validity.

1. TREE OF PORPHYRY

1. To begin with, the Porphyrian Tree is nothing real. None ever grew on earth, not even in Oregon or California. A Porphyrian Tree is a logical entity, a figment of the human mind. It is a *systematic arrangement of concepts* and through them of beings. But because such an arrangement when put on paper may be made to look like a tree, the system itself is called a tree, and because the first to suggest the idea was *Porphyry,* a philosopher of the third century A.D., all such systems are now called Porphyrian Trees (Trees of Porphyry).

2. In order to get at the basic idea of such Trees, let us compare three concepts with which we are all familiar: animal, brute, man. If we reflect on the relations of *identity and diversity* between them, we come to the following conclusions: Man is not a brute, nor are brutes men; but both men and brutes are animals. In other words, "man" and "brute" cannot be *predicated* (in recto) of each other, but "animal" can be predicated of both. The possibility of such predication is indicated, graphically or diagrammatically, by arranging the three concepts thus:

ANIMAL

MAN — BRUTE

The diagram is really shorthand for a *series of propositions* with the copula "is" or "is not" (identity or diversity): Man is an animal; the brute is an animal; man is not a brute, and viceversa; an animal is either a man or a brute etc.

The diagram also reveals what is meant, in logic, by three fundamental terms: genus, species and difference. "Animal" is here taken as the *genus;* it can be predicated of man and brute, though the two are essentially different. Man and brute are two *species* of "animal".[1] To the common genus "animal" are added two *specific differences*: rational, which gives us "man", and non-rational, which gives us "brute".—Merely for the sake of further illustration, let us take the oak, which, according to botanists, is a genus and has various species: white oak, post oak, pin oak, scarlet oak etc. They are all true oaks, but each is differentiated from the others by a specific characteristic.

3. Now let us add a fourth concept to the three with which we operated so far. It is possible to bring two or more genera under a *higher genus.* Thus both plants and animals are "living beings" (i.e. have vegetative life). That which differentiates them is called *generic difference.* Animals are endowed with sensitivity (or with the power of locomotion, if you will), plants are not. Plants lead a purely vegetative life.

4. It stands to reason that we must eventually arrive at a *highest genus* (genus supremum) or highest genera. Now the highest genera of all creatures are called *categories* or *predicaments,* and a natural series of genera and species, beginning with a highest genus and descending to the lowest species (species infima), is technically known as *"predicamental tree",* which is the same as Tree of Porphyry.

Such a series was correctly worked out by Porphyry, and is usually arranged as follows today:[2]

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[1]This statement will have to be modified later, but it may stand now for the sake of simplicity. We are not now concerned with what exactly corresponds to the diagram.

[2]Cf. Migne PL v. 64 (under Boethius).

SUBSTANCE

Material — Immaterial

BODY

Living — Non-living

ORGANISM

Sensitive — Non-sensitive

ANIMAL

Rational — Non-rational

MAN

This diagram is again shorthand and is meant to enunciate the following propositions: Man is a substance, not a mere accident. But he is a material substance; he is not immaterial or incorporeal like the angels. He differs, however, from other material substances first of all by possessing vegetative life, which the granite for instance has not. Again he differs from plants because he has sense life. Finally, he differs from brute animals, which also have sense life; for man alone among all animals is rational.

The diagram may also be read as follows: Every substance is either material or immaterial; every material substance is either living or non-living; every living material substance is either sensitive or non-sensitive; every sensitive substance is either rational or non-rational. If we read the

diagram in this way, we proceed by way of *dichotomy*, as logicians call it. Each division and subdivision consists of *two members* only, one of which expresses a positive perfection (e.g. living), the other its contradictory (e.g. non-living). The distinction is therefore complete at every step, and no third member is possible anywhere.

5. So much for the general pattern of Porphyrian Trees. To bring out their basic idea still more, let us compare them with the system of *chemical elements* denominated after Mendelejeff, the famous Russian chemist.

Mendelejeff's system bears a superficial resemblance to a Porphyrian Tree, but it is built on a wholly different plan. The ultimate test lies in the *reading*. In a Porphyrian Tree the single branches indicate identity or diversity, and can therefore be made predicates of logical propositions ("is", "is not"). But Mendelejeff's scheme merely means that the properties of the elements *vary periodically* as their atomic weights (periodic law). The difference is unmistakable. We may add that no chemist has yet discovered the reason for this periodicity—which means that we do not yet fully understand Mendelejeff's tables. Perhaps when we do, we shall be able to construct a predicamental tree also for the chemical elements.

We shall see later that there is a similar disagreement in basic ideas between the genealogical trees of evolutionists and true Porphyrian Trees.

2. CONSTRUCTION OF PORPHYRIAN TREES

Being natural series, Porphyrian Trees, to have any value, must be based on reality, on a comparison of beings furnished by experience. But their construction may proceed in either of two ways. One may either begin at the top or at the bottom. Taking all beings of a class (e.g. animals), one may first divide them into two or more clearly marked di-

visions, then subdivide these and so on, until the lowest natural classes, the species, are reached and classified. Dichotomy may be used, as exemplified in the above diagram. But while it gives logical satisfaction, it is not the only method and may lead to very clumsy divisions. Its great disadvantage is that the negative member of each division (e.g. non-rational) is altogether indefinite and contains no principle of subdivision.

The second method begins at the bottom. First the species infimae are established, then species are compared with species to discover genera; next genera are compared with genera to discover, if possible, higher genera, and so on until the highest is reached and all species as well as lower genera subsumed under it.

3. REALITY OF THE PORPHYRIAN TREE

Porphyrian Trees look and are artificial. But is there nothing solid behind them? Are they pure figments of the human mind? Have they no objective validity at all?

Linné, looking into this question, did not exactly discuss the Tree of Porphyry, but genera and species. He may have had the right idea, but he is not quite consistent in his pronouncements. In one of his treatises he says: "Classis et Ordo est sapientiae, Species naturae opus"; but elsewhere he says: "Genus omne est naturale, in primordio tale creatum".[3]

But really, as regards objectivity, there is no difference between genera and species. Also the term "genus" may be taken in three ways, and its objective validity in each sense is the same as that of "species". While "genus", taken in the first sense, exists as much as the species, if taken in the second or third sense, it cannot exist as such, for the simple

[3]Cf. Lyell II p. 267; Locy p. 311.

reason that only individuals can exist. There is this difference, however, that a genus cannot exist except in its species; there is no such thing as just an oak; each existing oak is of a definite species. The reason is that nature creates only wholes, and the genus is essentially incomplete.

The Tree of Porphyry, on the other hand, is essentially a series of relationships between abstract concepts; it is therefore a figment of the mind. Nevertheless it has objective validity if its foundation is real and if it is constructed correctly. Or we may say that it has objective validity if the propositions which it contains implicitly, are true.

CHAPTER 21

History of Classification

Science is order, synthesis, system. Science is *systematic knowledge,* a mental synthesis of all the data pertaining to a subject, an orderly arrangement in our mind of scientifically tested notions and principles and conclusions. The highest ambition of every science is to construct such a synthesis. Botany and zoology are no exception. Both aim at a comprehensive system that will make us fully understand the rational pattern behind the two kingdoms, so that naturalists then can proceed deductively.

In a rudimentary way, science is the birthright of all men. All have an innate tendency to bring order into what they know, to systematize things to the best of their abilities. Pre-scientific systems may be crude, faulty, fantastic perhaps, but they are a beginning; true "science" consists in controlling meticulously every step taken in the systematizing of facts, every notion inserted, every principle relied on explicitly or implicitly, every conclusion drawn from the premises.

In this chapter we shall briefly sketch the history of the attempts to reduce the infinite variety of plants and animals to a system.

1. GENESIS

The earliest such attempt seems to be contained in the first chapter of Genesis. The creation of plants is there assigned to the third day. They are divided into three classes: grasses, herbs and trees. Grasses (and mosses) were then thought to be without seed and to sprout spontaneously from the soil; herbs (cereals and vegetables) bear seed and constitute food for animals and man; trees produce

fruit which has in it the seed of new trees. On the fifth day God created fishes, big and small, and birds. Terrestrial animals, created on the sixth day, were divided into domestic animals, reptiles and wild beasts.[1]

These were evidently *popular classes* current at the time of Moses, the author of Genesis. Nor did Moses intend them as anything more, since his purpose was not scientific.[2]

2. THE ANCIENT GREEKS

The one to give the first impulse toward *scientific classification* in general, was *Aristotle*. He first distinguished between genus and species, the genus representing a wider class and narrowed down to species by essential differences. But he put forward no detailed framework for higher and higher groups.

Aristotle was not much interested in *plants* (or his writings on them may be lost), nor did he ever attempt to classify them. It was otherwise with *animals*. The "History of Animals", "On the Parts of Animals" and "On the Generation and Movement of Animals" are his chief zoological works. He was the first to notice a gradation from the lowest to the highest forms of life, and he made the perfection of an animal depend on the natural habitat (land, water, air), or on the prevalence of certain elements, or on the quality of the blood, or on the power of locomotion, or on size, or on the mode of generation, or on the number and perfection of the senses. But Aristotle nowhere joined these viewpoints into a coherent system. As a rule, he divided animals into 9 genera, though he admitted intermediary forms between some of them. Still, he has one supreme dichotomy:

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[1]Exegetes are by no means agreed on the exact meaning of the Hebrew words for these classes.

[2]Cf. the passage on the extent of Solomon's knowledge, quoted in the Preface.

animals with blood (enaima), meaning red blood, and animals without blood (anaima), but does not utilize this division, because one term is negative and therefore contains no principle of subdivision.[3]

Theophrastus, a contemporary of Aristotle and his successor in the administration of the Lyceum, merits the title "Founder of scientific botany"; Haller called him "primus verorum botanicorum". He divided the plant world into the two subkingdoms of the flowering and the flowerless.[4]

It was *Porphyry* who carried science a step further by inserting into the general pattern *intermediate* (subaltern) genera, lying between the genus supremum and the genera proxima. But he failed to apply his ingenious device to the classification of plants or animals.

3. SCHOLASTICS

Though Porphyry was one of the fiercest foes of Christianity in ancient times, the Scholastics adopted his improvements and showed that his pattern was philosophically sound. They applied it extensively in their own fields, but rarely ventured into the realm of natural sciences. Nor would they, with their limited knowledge, have succeeded.[5]

Still, their exegetical commentaries on the first chapter of Genesis show that they were aware of the problem. At the time of St. Thomas, they worried about the seeming confusion of genera and species of which Moses seemed guilty in his account of the sixth day of creation.[6] We can understand their embarrassment. It all came from reading that chapter as if it were part of a textbook on natural history, a practice not uncommon before Leo XIII.—It is in-

[3]Cf. Zeller II p. 509-512, 553-563; Locy p. 31-4.

[4]Cf. Locy p. 34-8; Holman and Robbins p. 10.

[5]Cf. Locy p. 92-7; Albert the Great's two treatises: De vegetalibus et plantis, and De animalibus.

[6]Cf. St. Thomas, Summa Theol. I qu. 72.

teresting to hear Suarez discuss the differentiation of animals into genera and species (De opere sex dierum, lib. 2 cap. 10). He distinguishes three "ordines seu classes, quae sunt veluti tria genera": fishes, birds and land animals—the first being the "lowest" of the three. He further counts two genera proxima of fishes: big and small, and three of land animals: domestic, wild and reptiles (snakes). Birds are not subdivided, because they do not equal the other two groups in number and variety. The astonished reader asks: Were there so few birds then in Salamanca and Coimbra? And had Suarez forgotten what he surely must have read in St. Basil's Hexaemeron about the infinite variety of birds? Anyhow, it all shows that systematics had made little progress since Moses.

4. PIONEERS OF MODERN SCIENCE

Things began to look up, at least for botany, with the dawn of the modern era. In the 16th century, *Andrea Cesalpino,* an Italian botanist, made an attempt to group plants according to natural affinities. He wrote De Plantis, libri XVI (1583). In the first book, he distributed the 1520 kinds of plants known to him into 15 classes, the differences being taken not from the roots or leaves or flowers, but from the organs of fructification. On that account, Linné called him "primus verus systematicus".[7]

A century later, *John Ray,* the "father of English natural history", did much to advance systematics. In his "Methodus Plantarum" (1682), he divided all plants into flowering and flowerless, subdividing the former into dicotyledons (with two seed-leaves) and monocotyledons (with a single seed-leaf). His place in the history of systematics is fixed by his "Historia Generalis Plantarum" in three vol-

[7]But Sachs thinks that none of his groupings were new then, and that they are highly unnatural. Cf. Locy p. 151.

umes (1686-1704). But Ray was also interested in animals. He wrote an Ornithology (1676), The History of Fishes (1685), a Synopsis of the Quadrupeds (1693), and a History of the Insects (1710).

J. P. de Tournefort, a French botanist of the 17th century, neglected investigation of species, but drew attention to the genera of plants. Genera were for the first time systematically named and described in his "Institutiones Rei Herbariae" (3 vols. 1700). The 8,000 species of plants which he knew, he distributed into 22 classes, chiefly according to the form of the corolla.

Carolus Linnaeus or Karl von Linné, a Swedish scholar, is rightly regarded as the father of modern systematics. He it was who introduced names for intermediate genera, put descriptions of species on a scientific basis, and urged the adoption of the binomial system.[8]

Linné was interested in botany and zoology. His "Systema Naturae", first published in 1735, contained his descriptions of plants and animals; its tenth edition (1758) has been accepted as the basis of modern nomenclature. His "Species Plantarum" (1753) furnished the basis for scientific plant names. His own botanical system was based on differences in stamens and pistils, the so-called sexual organs of the flower, and hence is often referred to as the sexual system. He arranged all genera of plants under 67 orders.[9]

As regards the animal kingdom, Linné chose for his first principle of division the color and temperature of the blood. He divided all animals into 6 great classes: mammals, birds, amphibians, fishes, insects and worms. For subdivisions he chose as principles the heart, respiratory organs and the mode of reproduction.

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[8] Cf. Locy p. 310-321.
[9] Cf. Locy p. 364-8.

"The subdivisions of the animal and plant kingdoms established by Linnaeus are, with few exceptions, retained in the modern classification, and this despite the enormous number of new forms discovered since then. The new forms were either included in the Linnaean groups, or new groups have been created to accommodate them. There has been no necessity for a basic change in the classification" (Dobzhanski, quoted in E. Mayr p. 276). But Linné himself was well aware that his system was artificial, constructed rather for convenient reference and identification. He never worked out a natural system.

5. FRENCH NATURALISTS

A. L. de Jussieu tried to get rid of the "artificial" systems of Cesalpino and Linné, and classified plants according to their "natural" orders (Genera Plantarum 1789). His "orders" were groups of genera such as now are called families. With John Ray, he chose as his first principle for dividing plants the number of cotyledons. He also put forward the principle of the "subordination of characters", which should lead to the establishing of genera; the "dominant" character constitutes the genus, and the characters of the species are subordinated to it. The same principle holds true for higher genera.[10]

J. B. Lamarck, after 25 years of work in botany, took up zoology. He was the first to divide animals into vertebrates and invertebrates.[11] *Vertebrates* are the higher animals, the

[10]Cf. Locy p. 368-371.

[11]Lamarck narrates (Zool. Phil. p. 62) that he introduced this division in his first course of lectures at the Museum in the spring of 1794 (the year II of the Republic): "I called the attention of my pupils to the fact that the vertebral column, among animals provided with it, indicates the possession of a more or less perfect skeleton and of a plan of organization on the same plane; whereas its absence among other animals not only distinguishes them sharply from

first four of Linné's classes: mammals, birds, amphibians and fishes. The *invertebrates,* the last two of Linné's classes, were broken up into 10. Lamarck thus obtained *14 genera suprema.*

Lamarck also introduced another change. While Linné had arranged his classes so as to proceed from the most complex to the simplest, and so began with mammals, Lamarck reversed this order and began with infusorians.[12]

G. L. Cuvier and later zoologists adopted Lamarck's division and order of animals, though they introduced various subdivisions. Cuvier himself is famous for his theory of "embranchements" or "types", each of which presents a radically distinct plan of organization. He distinguished *4 types*: Vertebrata, Mollusca, Articulata, Radiata.[13]

The division of vertebrates into 5 phyla instead of 4 was due to *H. Milne-Edwards,* a French naturalist, who, on the strength of embryology, separated the reptiles from amphibians, and created the phylum Molluscoida.

We may add here the name of the great Austrian botanist *Stephen Endlicher,* curator of the Museum of Natural History at Vienna, who wrote "Genera Plantarum secundum ordines naturales disposita" (1836-50). This work is regarded as one of the fundamental writings of systematic botany.[14]

6. NEW WORLDS TO CONQUER

The progress of science enriched our knowledge in two directions, but also complicated the task of the systematist.

1. The invention of the *microscope* opened up an entirely new world swarming with life, but hidden to man's eyes

the first, but shows that their whole plan of organization is very different from those of vertebrate animals".

[12]Cf. Lamarck ch. 8.

[13]Cf. Locy p. 325.

[14]Cf. Cath. Enc. s.v. Endlicher.

until the 17th century. The writings of the Jesuit Athanasius Kircher furnish us with the earliest authentic notices of microscopically minute living organisms. Anthony van Leeuwenhoeck, of Delft in Holland, devoted a long life to studies with the microscope. He discovered the single-celled animals, after him called protozoa, as well as bacteria, much smaller than protozoa. Amebae and infusoria were discovered later.

Otto Friedrich Müller supplied generic and specific names for these new organisms and arranged them in systematic order.

2. Duhem emphatically states that Leonardo da Vinci created the science of paleontology inasmuch as he gave a correct explanation of the origin of *fossils.* But inasmuch as *Cuvier* was the first to classify fossils, he became the father of paleontology as distinct from geology. But the real first systematist was *K. A. Zittel,* who gathered whatever was known about fossils and joined their forms to the animals now living.[15]

[15]Cf. Dacqué p. 171-7; More p. 122-8, 136.

CHAPTER 22

Modern Classification

In this chapter we shall first describe the nomenclature and the binomial system now in vogue among naturalists. Then we shall outline present-day classifications of plants and animals, indicating at the same time the attitude of modern Scholastics toward them. Finally, we shall point out some of the obstacles that beset the path of the modern systematist.

1. NOMENCLATURE

1. The commonly accepted list of *group names,* in ascending order, is as follows: Species, genus, family, order, class, phylum, kingdom. The single names may be compounded with "sub" (subkingdom, subphylum etc.) when the next lower group consists of a very large number of members. They may also be compounded with "super".[1] No a priori objection can be raised against such a practice. Reality may be found to be far too rich to be squeezed into a simple logical system.

As an *example* of modern nomenclature and classification, let us take our friend, the dog.

Though the variety of dogs seems infinite, yet they all belong to one *species,* "Canis domesticus" or "familiaris". The wolf is "Canis lupus" and the jackal "Canis aureus". All three are of the *genus* "Canis", though there are other species. The next highest group, the *family,* are the "Canidae". Many families together constitute an *order,* in our case the "Carnivora". Dogs are of the *class* "Mammalia", because they suckle their young, and of the *phylum* "Vertebrata" (or Chordata), because they have a backbone. Last-

[1]Cf. Chidester p. 13; E. Mayr p. 169.

ly, dogs belong to the *kingdom* "Animal" or better "Animal brutum".

2. The *scientific names* of plants and animals are today constructed on the binomial system introduced by Linné, They consist of two words, the first, usually capitalized, giving the *genus proximum,* the second the *specific difference.* An example is the above "Canis domesticus". Sometimes, to indicate a subgenus, a third word is placed in parentheses; e.g. Ursus (Euarctos) americanus. "Taxonomists recommend that after the species name there be placed also the name of the scientist who *first classified* the species in accordance with the Linnaean method. To illustrate, the full description of the domestic cat would be Felis domestica Linnaeus (because Linnaeus first classified the species), instead of just Felis domestica" (Fasten p. 83).[2]

By common consent, *family names* of animals end in -idae, those of plants in -aceae.

3. There can be no doubt that this recent nomenclature is, on principle, a praiseworthy innovation, and it is accepted by most *Scholastics.* I do not see how P. Coffey (I p. 80) can here charge a contradiction between the old and the new.

One might possibly object to the term "subspecies". As G. S. Miller explains, zoologists give that name to "the local forms which a species assumes in different parts of its range (as the huge wolf of our northern forest, the smaller wolf of the Arctic tundras, the dark-colored wolf of Florida, and so forth)". Since these differences are infraspecies, the term would seem misleading. Besides, we have plenty of other terms to designate the same thing: race, breed, variety etc.—E. Mayr (p. 290) objects to the term

[2]Cf. E. Mayr p. 16-7; Hegner, *College Zoology* p. 25-6; Holman and Robbins p. 15.

"subgenus", a name which "has never been particularly popular"; he thinks "species group" would be preferable.

2. HIGHEST GENERA

It has been shown in chapter 2 that life below man comprises two grand divisions: plants and animals. Modern naturalists call them "kingdoms", and they are undoubtedly the highest genera. But we are now concerned with the divisions *immediately* below them.

1. *Highest Genera of Plants*

a. Adolf Engler, a German botanist, is the great systematizer of modern times. Like his predecessors, he proceeds by way of dichotomy, dividing plants into two genera suprema: *phanerogams* (flowering) and *cryptogams* (flowerless). Flowering plants are divided into *gymnosperms* (seeds not enclosed in a fruit) and *angiosperms* (seeds enclosed in a fruit). Angiosperms are subdivided into monocotyledons and dicotyledons, the former being again divided into some 11 orders, the latter into some 40. Flowerless plants are grouped in 3 main divisions: Thallophytes, Bryophytes and Pteridophytes.

Still, while perhaps the more common, this division is not universally accepted. Der grosse Herder (art. Die Pflanze), though claiming to follow Engler, divides plants first into Thallophytes and Cormophytes, and then subdivides the former into 13 groups, the latter into 3. American botanists do not follow Engler's dichotomy; they prefer to divide all plants at once into a number of phyla or divisions. The usual enumeration is as follows: Schizophytes or Myxophytes, Thallophytes, Bryophytes, Pteridophytes, Spermatophytes. But C. J. Hylander (p. 8-12) enumerates 10 phyla, while admitting that the first seven are often grouped together under the name of Thallophytes, and that the last

three are the Cormophytes. The difference between them is the possession of roots, stems and leaves. He also subdivides the last phylum, the Spermatophytes into Gymnosperms and Angiosperms. MacDougall (p. 76-9) has only 3 phyla: Thallophyta, Bryophyta and Tracheophyta; the first, however, has 2 subphyla, the last 4. Holman and Robbins (4th ed. 1938 p. 15) has two subkingdoms: Thallophyta and Embryophyta; the subdivisions of the former are Algae and Fungi, of the latter Bryophyta, Pteridophyta and Spermatophyta.

b. Few of the modern Scholastics voice any opinion on the subject. T. Pesch (Inst. Phil. nat. II n. 582) simply takes over Engler's system. Donat (Cosm. p. 362-3) divides all plants into 5 phyla: Thallophyta, Bryophyta, Pteridophyta, Gymnospermae and Angiospermae. Urráburu (I p. 589) adopts the division of a certain van Tieghen, which agrees with Engler's, except that it is preceded by a distinction between rooted and rootless plants. But he wisely adds a warning: "There is uncertainty, and no division has yet been devised which brings order into everything, or which has not its own drawbacks".

2. *Highest Genera of Animals*

a. Following Lamarck, modern zoologists agree in dividing animals first into *Invertebrates* and *Vertebrates* (or vice-versa, if one prefers to follow Linné). The chief groups of the Invertebrates are: Protozoa, Sponges, Coelenterates, Echinoderms, Worms, Mollusks, Crustaceans, Spiders, Insects. Vertebrates are divided into 5 main classes: Fishes, Amphibians, Reptiles, Birds, and Mammals. There are 11 orders of Mammals, the Primates being the highest in the scale of life.[3]

[3]Linné and other zoologists would include *man* among them; but since classification is of wholes, not of parts, such a procedure is unjustified (infra p. 240).

Neither is this classification acceptable to all zoologists. H. E. Ziegler at once divided animals into 9 phyla (Stämme); so did K. Claus in his famous Lehrbuch der Zoologie (1880; 8th ed. 1909). P. E. Raymond (p. 19) divides the whole animal kingdom into 13 phyla, but adds that "this may not be in agreement with the best modern practice". Chidester (p. 16-20) places all Vertebrates in one phylum and divides Invertebrates into 11 (or 12) phyla. MacDougall (p. 80-91) has 14 phyla. Hegner (College Zoology p. 2) is satisfied with 12. Fasten says (p. 87): "There is considerable disagreement among zoologists regarding the number of phyla of animals. Some list as few as a dozen, while others recognize considerably more—from eleven to twenty-four. However, the majority of zoologists are of the opinion that sixteen phyla are ample as a basis for the classification of practically all the known species."

It seems a bit premature then when Professor Yonge declares that "the great phyla are now established with universal consent" (p. 202). There is no consent either for plants or animals.

b. Of the Scholastics, Urráburu (I p. 719-721) and T. Pesch (Inst. Phil. nat. II n. 582) accept Claus' division. Donat writes (Cosm. p. 362): "Different authors give different figures for the highest phyla: 7 or 9, 10, even 16 and 17". He himself is content with 7: Protozoa, Coelenterata, Vermes, Echinodermata, Mollusca, Arthropoda, Vertebrata. He then subdivides the Vertebrates into 7 classes, and the seventh class, Mammalia, into 11 orders. Fröbes (Psych. spec. I p. 13) says he is using the following order of 8 grand divisions of the animal kingdom: protozoa, porifera, coelenterates, echinoderms, worms, molluscs, arthropods, vertebrates. The Vertebrates are divided into 5 classes: fishes, amphibians, reptiles, birds and mammals. He does not

justify his divisions. Fr. Dezza (p. 79) accepts "le prime grandi divisioni sia delle piante che degli animali", but does not tell us which are the first grand divisions.

3. INTERMEDIATE GENERA

We may thus call the three divisions between phyla and lowest genera, viz. classes, orders and families. More so perhaps than in the preceding section, naturalists are divided in their classifications. Let us take some examples from the animal world.

M. S. MacDougall (p. 88) divides *reptiles* into 4 orders: Chelonia, Rhynchocephalia, Crocodilia, Squamata. But Percy Moore (Encycl. Amer. s.v. Reptiles) divides them into 11 sub-classes, each sub-class containing two or more orders; the last sub-class contains the two orders Lacetilia (lizards) and Ophidia (snakes). D. M. S. Watson (Encycl. Brit. s.v. Reptiles), premising that the classification of reptiles "is still in a state of flux", offers us super-orders, orders and sub-orders. But while he has only 7 families of snakes, H. W. Parker (Encycl. Brit. s.v. Snakes) knows 10 families and divides them into sub-families. Hegner divides the class Reptilia into 4 orders, two of them having sub-orders; he has only 5 families of snakes, though with sub-families and series. Webster (s.v. Reptilia) enumerates 9 orders, of which 5 are extinct.

As regards *birds,* which is class Aves, it will be sufficient to cite Hegner, who says (College Zoology p. 546): "More than fourteen thousand species of living birds have been described, and no two authorities agree as to their classification". M. S. MacDougall (p. 495) gives the reason for this disagreement, viz. because ornithologists cannot agree on the basis of classification, some using the type of food,

others the method of locomotion, others again anatomical features.[4]

Hegner groups all *mammals* (some 4,000 species) into 3 sub-classes and 19 orders. MacDougall (p. 90) also has 3 sub-classes, but only 17 orders.

4. LOWEST GENERA

In modern scientific nomenclature, the genus, meaning genus proximum, is a category below family and above species. Thus horses, asses, zebras constitute the genus Equus; the various species of oak form collectively the genus Quercus.

Though the first word of the binomial scientific name is supposed to indicate the genus, yet the present standing of the term is precarious. Naturalists admit that there is a good deal of arbitrariness about genera. C. J. Hylander, in his "List of Plants", skips genera of plants and enumerates many species of each family. But while the genera of older taxonomists like Linné were large and comprehensive groups, in many cases coextensive with the families of modern taxonomy, the present tendency is to restrict genera to much more closely related groups.

The genus seems more secure in zoology, though Hegner stops with families, barely mentioning genera. But a puzzling phenomenon is the high percentage of monotypic genera by the side of genera comprising huge numbers of species. Thus the "American Ornithologists' Union Check List" (1931) contains 53 monotypic genera out of 127 genera of Passerine birds; on the other hand, the hawk is credited with 45 species and the weaver bird with 55. Among Invertebrates, and especially among insects, there are genera with 500, 1,000 or even 2,000 species.

[4]Cf. E. Mayr p. 281-2.

5. WOES OF THE SYSTEMATIST

The upshot of the last few pages is the evident conclusion that systematics has fallen on evil days. It is not all the fault of the individual taxonomist, who is handicapped in many ways.

1. There is the lack of a uniform and well-defined *nomenclature.*

As from the beginning, so now neither the group names nor their meanings are fixed and univocal. The Standard Dictionary e.g. defines the phylum as "a great division of the plant and animal kingdom, below a subkingdom and above an order"; but Webster identifies phylum, subkingdom and branch. The Standard Dictionary gives two definitions for "order", one for zoology (a group of families), another for botany (a group between a genus or tribe and class). Some systematists subdivide orders into series, others identify tribe and family. Even international congresses have been unable to bring about uniformity.

There is also a historical difficulty, inasmuch as the same group name did not always include the same objects; group names have, in the course of history, been stretched or contracted. Thus Cuvier classed the Amphibia with the Reptilia, calling them "naked reptiles"; Milne-Edwards later separated them into two phyla. He also created the phylum Molluscoida; but while he included in it Bryozoa and Tunicata, the latter were subsequently ousted and Brachiopoda added.[5]

Popular names and divisions create a further difficulty. As we saw before, the puma once sneaked around under 19 different aliases. The hare and the rabbit mean the same thing to most people, though zoologists insist that they are distinct, in fact two distinct genera, each with numerous

[5]Cf. Chidester p. 127.

species and subspecies. Are the bobwhite, the partridge and the quail the same or different birds? Who can tell?

This suggests a famous dispute between popular and scientific nomenclatures. Is the whale a fish? Zoologists say no, because whales are mammals, and no mammal is a fish. To the unsophisticated layman, however, the whale is as much a fish as the herring or the dolphin, which people the oceans of the earth; if there is any difference, it is merely in size. Who is right?

Both—as long as they realize that they talk a different language. Both would be wrong if they were to intimate that the other fellow does not know what he is talking about, or that his name is not justified by facts. To the layman, a fish is an animal whose habitat is the water, in which it freely swims about; that definition fits the whale. The naturalists distinguish mammals from fishes, and since whales are evidently mammals, they can't be fishes.

2. A far more serious handicap for the systematist, however, is the lack of essential *definitions* and universally valid *criteria*.

Classification, as actually carried on, lacks that philosophical underpinning without which no sound system is possible. The philosopher must ask: In what precisely does the genus differ from the species, the family from the genus, and so on? Or to put it another way: What constitutes the generic difference, the family difference, and so on?

E. Mayr says (p. 283) that "few authors have dared to define genus". He himself proposes marked gaps between similar groups of species. But this would be a purely extrinsic criterion, just as we said in the case of species, and would be subject to the same uncertainties of application. The philosopher at least looks for generic differences that will touch the very essence of the groups. For genus is part of the essence.

Not only are essential definitions lacking, but also criteria for establishing higher classes. We heard MacDougall say just now that ornithologists cannot agree on the basis for a classification of birds. G. S. Miller (1928 Report of the Smithsonian Inst. p. 410) finds the same obstacle in the case of mammals: "At present", he says, "we are applying one set of criteria to the study of mammals preserved as skins, skeletons or pickles, another set to those preserved in rocks, and a third to those with which we come in social contact. As a result . . . the opinions regarding generic, specific and subspecific distinctions held by workers on fossil mammals are, on the whole, incommensurate with those which are being applied to the study of the living kind". Prof. Yonge (p. 203) goes so far as to say that "there are no criteria whatsoever for the grades of classification between phyla and species, and difficulties increase as the descent is made from class to order, then to family and finally to genus. None of these is capable of definition".

As a result, the drawing up of systems depends to a considerable extent on the individual judgment of the systematist. This is frankly admitted by Prof. Yonge (l.c.). It is also adverted to by "Standardized Plant Names", published by the American Joint Committee of Horticultural Nomenclature (Salem, Mass. 1924): "Much more important are differences of personal judgment among botanists as to what constitutes in any given case a sufficient difference between two groups of related plants to place them in different genera; for example, whether the known difference between apples and pears is enough to separate them into genera, Malus and Pyrus, or is so slight that they should be consolidated into a single genus" (p. vi).

E. Mayr seems justified when he concludes (p. 289) that "we cannot blame the nontaxonomist for developing a rather low opinion of the taxonomist when he comes across such

type of work". He refers specifically to the "excessive splitting of the higher categories", but his words apply to other features of modern systematics as well.

3. Systematists also seem undecided about the *method* to follow. Should they begin at the top and work down? Or should they begin at the bottom, that is, with natural species, and work up from them to the higher and highest classes? Actually, naturalists favor the former method; but owing to the uncertainty of its procedure, the latter method would seem preferable.

However, even if one begins on top, he is not tied down to dichotomy. It is just as legitimate and more practical to divide all animals or plants into a number of genera suprema. As we saw, many naturalists do so. How clumsy dichotomy becomes if adhered to too rigidly, may be seen in Prof. Berry (p. 5), who divides all animals first into Protozoa and Metazoa. He admits that the name Metazoa "does not find a formal place in classification because it embraces such a diversity of unrelated forms". Still, being logical-minded, he divides them by way of dichotomy—first into porifera or sponges and the remainder; the remainder is then subdivided into Coelenterates (corals, sea anemones, jelly fishes), which have a "gastrovascular cavity", and the remainder. From here on the classification becomes so complicated that it would be useless to proceed further.

But where dichotomy is impossible or impractical, a further difficulty arises: In what *order* should the various groups be arranged? Or to put the same question historically: Who was right, Linné, who started from the more complex form, or Lamarck, who placed the simpler form first? However, this problem would seem to be, on the whole, a minor issue.

CHAPTER 23

Genealogical Trees

The uncertainties of classification were doubled and trebled with the advent of the theory of evolution. A new principle was thrown among systematists, so that they felt obliged to revise their classifications from top to bottom. We shall first describe and appraise the scientific theory of evolution on which the new classifications are based, and then examine its claim of being helpful for that purpose.

1. THE SCIENTIFIC THEORY OF EVOLUTION

As we saw above (p. 100), the theory of evolution is today proposed in two forms, one the popular, the other the scientific form. There is some relation between the two, but we now deal with the latter.

1. Before Linné changed his mind, he thought that all species of a genus were originally one, but were later differentiated by hybridization. Though one may see in this the germ of the scientific theory of evolution, Linné cannot be classed among evolutionists. He not only acknowledged the necessity of a Creator, but he also changed his mind, defending in after years the priority and fixity of species.

After him came Lamarck. Being a good Catholic, he admitted the Creator, but his studies of plants and animals led him to formulate a theory of creation by means of evolution. He thought that God had created originally only rudimentary organisms and an order of things (law of nature) whereby they became differentiated into species by adapting themselves to the environment. "Life and organization are products of nature, and at the same time results of the powers conferred upon nature by the Supreme Author of all things and of the laws by which she herself is con-

stituted" (Zool. Phil. p. 236). In his theory therefore the major changes did not come about by chance, but in accordance with a divine plan through the working of a law of nature.[1]

Owing to Cuvier's relentless opposition and unsparing ridicule, Lamarck's theory was long neglected in France and Germany, though Lyell was influenced by it while preparing his "Principles of Geology".[2] Darwin was congenitally incapable of grasping Lamarck's grandiose ideas and stuck to the popular brand of evolution. But the basic idea of the modern theory of evolution hardly differs from Lamarck's except that the Creator has been eliminated. It, too, maintains that all species existing now evolved from one or a few simple organisms, becoming ever more complex and differentiated during succeeding geological ages.

Characteristic of the new theory is the primary division of living beings, man included, into *Protozoa* (one-celled) and *Metazoa* (many-celled). Science knows, of course, one-celled and many-celled organisms. But the new division derives its importance from the assumption that the first living things on the sea-shore were one-celled organisms, which, slowly or rapidly, evolved into many-celled organisms. Out-and-out evolutionists even claim that the earliest of them, sometimes called Protista, were generic beings, not yet differentiated into plant or animal.

2. There is scarcely any need of quoting references for this outline of the modern theory of evolution. I shall therefore limit myself to citing a few recent authors, themselves evolutionists.

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[1]A similar theory had been proposed tentatively by Buffon and by Erasmus Darwin. But if Lamarck had reflected on this novel hypothesis, he should have realized that it was manufactured out of thin air; he can cite no facts in its support. Cf. More p. 144-6, 163-184; Marcozzi, in Civiltà Catt. Dec. 20, 1941 p. 424.

[2]Cf. Osborn p. 278-300, 325-6.

H. H. Newman (in Newman's The Nature, etc., p. 192) writes: "The theory of evolution holds that, once life got started, it began to change at once in adaptation to diversified conditions in the environment; that, in general, the changes have proceeded from more plastic, generalized types to less plastic, specialized types; that immense numbers of highly developed types have appeared, have thrived for a time, and have died off; and that the forms now living are merely the present end-products of thousands of lines of specialization, each descended from the simplest form of life".—N. Fasten, speaking of Euglena and Volvox, says (p. 30): "From a biological standpoint, these organisms are extremely interesting. It is from types similar to these, through specialization in different directions, that the independent plant and animal kingdoms have evolved". And further on (p. 50) he adds: "After the environment changed, this simple living material had to adjust itself and had to become more complex. The ultimate result was that slowly and definitely various types of living organisms originated".

Referring to the huge collections of fossils in our museums, L. T. More writes (p. 15): "From what we have collected from the past and from observation of forms at present alive, a theory of evolution has been laboriously developed which explains our existing life as the result of a continuous modification of previous forms, going back to simpler organisms until we reach a world of inorganic matter with here and there tiny masses of protoplasmic jelly scattered on the shores of the ocean, themselves indistinguishable from the mud in which they lie".

It stands to reason that if such is the origin of our flora and fauna, then the various classes of plants and animals, whether living or extinct, can be arranged *genealogically* according to their pedigrees. Such genealogical trees are as a matter of fact given today in many textbooks of botany and

zoology. Sir Arthur Keith states boldly (p. v): "The botanist and zoologist cannot breathe or move at his work unless you permit him to be an evolutionist".

3. What are the proofs on which this theory rests?

Modern evolutionists advance five standard arguments to prove the general fact of evolution: from embryology, from morphology, from paleontology, from geographic distribution, from genetics and experimental biology.[3]

To be quite frank, four out of the five arguments have always struck me as truly childish in their logic, props for wishful thinking. L. T. More, though a staunch evolutionist, calls them "secondary evidence" (p. 119); "secondary reasons", born of "our desire to eliminate special creation and, generally, what we call the miraculous" (p. 117; cf. p. 120-1, 161-2). The only argument of any weight is the one from *paleontology*. It claims to show that the fossils of former geological ages reveal a gradual ascent of living beings—from the lower to the higher, from the simple to the more complex—which is of the essence of the scientific theory of evolution. To Darwin's own mind the discovery and knowledge of fossils was the evidence which alone could change the doctrine of evolution from an abstract hypothesis to a concrete fact.[4] Huxley shared the same conviction.[5] L. Boule says: "It has always seemed to me that the fact of evolution should stand or fall by Palaeontological evidence".[6]

4. Not a few *Catholics* today favor Lamarck's theory: Wasmann, Vialleton, Dorlodot, Frank, de Sinéty, Donat, Dwight, Agar, Brennan, Maquart and others. But while

[3]Cf. Fasten p. 639-648; Chidester p. 525-531; Giesen-Malumphy ch. 10; de Sinéty, in Dict. prat. s.v. Evolutionnisme; Beraza p. 492-5; Agar p. 73-82; Monaco p. 222-39.
[4]Cf. L. T. More p. 117; O'Toole p. 66.
[5]Cf. Gerard p. 204-5.
[6]In "God, Man and the Universe" (ed. Kologriwof) p. 134.

the ordinary run of evolutionists are bent on ousting the Creator from His universe and claim that there was one type of organism to begin with (monophyletic evolution), Catholic Lamarckians postulate a multiplicity of original types (polyphyletic evolution) and, with Lamarck himself, place God at the beginning of each type.[7] Donat explicitly disproves monophyletic evolution (Cosm. p. 379, 393), and Frank's second conclusion is this (p. 228): "There arise, it is true, new species, genera and even families, but no animals and plants with an entirely deviating plan of construction and higher total organization". de Sinéty must be of the same mind since he allows no transition from one phylum to another, from one class to another, from one order to another (Dict. apol. s.v. Transformisme col. 1818-9). Fr. Descoqs' position (p. 97) is not quite clear.[8] But Fr. Teilhard de Chardin foresees the day when biologists will have proved monophyletic evolution.[9]

To understand Catholic Lamarckians better, we must add that they operate with two types: the "structural" type and the "formal" type. The former exhibits such a fixed coordination of parts that it cannot come about gradually; its characteristic traits cannot be sundered; nor can they exist in an imperfect state because then they would be useless and even harmful to the living organisms. The "formal" type is made up of more external and quantitative characters and rather indicates accidental differences.

Catholic Lamarckians then say that each of the higher categories of plants and animals (phyla, classes, orders) has its own structural type, and that therefore no transition is possible from one to another; they also claim that paleontology furnishes no intermediate link between any two

[7] Cf. Monaco p. 174; Maquart p. 523-7.
[8] Cf. Motherway, in Theol. Studies 1946 p. 479.
[9] Cf. Etudes 1947 p. 257.

of them. The opposite is true of the lower categories (families, genera, species); transition is possible from one to another, and paleontology has brought to light intermediate links between many of them.

Following L. Vialleton, Fr. Boyer likewise distinguishes (p. 113) between the "typus formalis" and the "typus organizationis", calling the latter "typus proprie dictus seu species proprie dicta" and restricting it to phyla, classes and orders. He then admits mutability of one formal type to another, but not of one structural type to another.

2. DEMURRER

In chapter 3 we proved, from Scripture and reason, that God stands at the beginning of life, that is, of each of the two kingdoms below man as well as of the human race. Supposing this, we now ask: What is to be thought of the scientific theory of evolution?

1. While the Lamarckian theory is not intrinsically impossible, the *present laws of heredity* make it extremely improbable, if not certainly false. The same arguments by which we disproved in chapter 12 any spontaneous transition from species to species, also disprove this theory.

They are at the same time the answer to Catholic Lamarckians, who shy away from monophyletic evolution, but think they can accept polyphyletic evolution. Donat's five arguments against the former, if valid at all, also disprove the transformation of natural families, genera and species. A change from one family to another, from one genus to another, from one species to another would have to be as total and instantaneous as from one structural type to another. We may grant at most that the impossibility of a sudden and total transition from one of the higher categories to another is more obvious than from species to species.[10]

[10] I do not see how Fr. Boyer can quote (p. 113-4) L. Vialleton in

According to Agar (p. 90), "the argument for evolution is a legitimate, incomplete induction which . . . is exactly the kind of evidence which makes faith in revelation acceptable to the reasonable mind". I shall not dispute the term "induction", which has a variety of meanings; what Mr. Agar means is convergence of probabilities, which is a good argument—if the single probabilities are really solid. But can this be said of the five arguments on which evolutionists base their theory?

2. The *Protista*, the supposed progenitors of all monophyletic evolution, are not only pure fiction, but logical monstrosities. L. T. More writes (p. 154): "Evolution must begin with animals high up in the scale of differentiation, and all stages from them to the prototypes which were originated supposedly in the warm ocean slime of the Proterozoic epoch are pure conjectures". Our fossil records may not be complete enough to decide whether certain early forms of unicellular life were plants or animals, but that does not justify us in assuming that generic Protista were the beginning of life on this globe. Such beings could exist as little as those generic cells of which "General Biology" used to speak. Only specific beings, individuals with a complete essence can exist.

3. Much could be and has been said about the argument from *paleontology*. Let the following suffice in this context.

a. L. T. More, a convinced evolutionist, quotes (p. 118) both Darwin and Huxley to the effect that the positive evidence which paleontology furnishes for the scientific theory of evolution, is either nil or insignificant. He himself writing in 1925, is sure that the evidence "is as incomplete as it was in the time of Darwin and Huxley" and that "it will always be *incomplete*".

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favor of his own thesis, according to which all natural species are due to God's direct intervention.

b. If the successive forms are forced into the strait-jacket of progressive evolution, paleontology is set at odds with the *geological time-table*.[11]

c. Evolutionists point to some *intermediate forms* which connect forms clearly distinct today. Perhaps the most famous is the Archeopterix, a fossil uncovered in the Bavarian Jura (1860), which E. Mayr calls "as perfect a missing link between reptiles and birds as one could hope for" (p. 296), since it clearly exhibits the characters of both. But the trouble is again the geological time-table. This and other "missing links" appear after or simultaneously with the forms to which they are supposed to lead.[12]

d. Who has ever furnished the positive proof that the later forms are *really descended* from different predecessors? No one, of course, has observed the descent during the geological ages. It is all inference. Not only that, but the principle underlying the whole argument from paleontology reminds the old-time logician of the sophism "post hoc, ergo propter hoc"; only now it would be "post hoc, ergo ex hoc". For succession does not necessarily imply physical descent.[13]

But does not the established geological succession of fossils make physical descent at least probable? If the present forms of flora and fauna differ less from those of the tertiary period than from those of earlier ages, is it not a legitimate inference that the later forms are descended from the earlier ones?

Yes, if the hypothesis did not clash with two certain facts, viz. the present unbridgeable gulf between species, and the present lack of any tendency of our species to change

[11]Cf. More p. 146-162; Dacqué p. 132-167, 172.

[12]Cf. Dacqué p. 153, 172; de Sinéty, in Dict. apol. s.v. Transformisme col. 1809-1810; T. Pesch, Inst. Phil. nat. II n. 596; Monaco p. 226.

[13]Cf. Beraza p. 492; Gruenberg p. 227-230.

or evolve into something essentially different, whether higher or lower, simpler or more complex.

W. M. Agar thinks that "it is exactly because evolution brings order into and gives meaning to so many and such varied studies that it is now generally accepted as true" (p. 82). No doubt, evolution has this advantage in common with every plausible hypothesis. But the honest seeker after truth will not be satisfied with mere plausibility; he will test his hypothesis, and the first test must be whether it accords with established truths. It is precisely our contention that evolution contradicts the present laws of heredity.

But is it not an undeniable fact also that the earth's flora and fauna have, in the course of geological ages, become more and more like the present? Yes. But this finds a satisfactory explanation in God's plan to prepare the world gradually for the coming of man. God might have created the world one second before Adam; but it is reasonably certain that the world existed millions of years prior to him and that it underwent profound changes during that time. Why God proceeded in this fashion in the creation of the visible universe, is a mystery.

e. Since the scientific theory of evolution postulates a *continuous progress* from lower to higher, the philosopher naturally asks: Which of the classes listed by naturalists are lower and which are higher?

Animals are higher than plants. Granted; but within the same kingdom, which classes are lower and which are higher? Vertebrates are said to be higher than invertebrates. Perhaps, but why and in what sense? It will not do to answer that vertebrates came after invertebrates according to paleontology and therefore are higher in the scale of life; that would be a vicious circle; for it would suppose evolution whereas evolution is to be proved by the grading. Moreover, in the theory of evolution, the various classes of both ver-

tebrates and invertebrates are again arranged in ascending scales. By what authority? On what principle?

Scholastics used to speak of lower and higher organisms according as their forms are less or more heterogeneous in their integral parts. This division may in principle correspond to the modern differentiation into simple and complex. Yet even if we accept the principle as correct, its application to the various genera, let alone species, is almost impossible, and the Scholastics never attempted it. Which, for instance, is higher, the cat or the mouse, the duck or the goose, the elephant or the hippopotamus, the rose or the lily, the apple tree or the cocoanut tree? The actual list of classes is so large and complicated that the mind becomes utterly bewildered when confronted with the task of telling which are lower and which higher.

Yet without settling this question first, it is meaningless to speak of evolution. Better terms, because less misleading to the unwary, would be transformation or descent.[14]

4. The philosopher has the right to ask still another question: Why were not the lower forms of life satisfied with being what they were—as they evidently are now? Why did they *tend to something higher?*

Lamarck, having been trained by the Jesuits, was philosophical enough to ask himself this question. He answered it by postulating a need or want, but he never proved the reality of such a need in a healthy plant or animal. A. R. Wallace assumed a tendency to depart from the original type, but gave no reason for such a tendency, and present-day laws are against its existence; varieties sooner or later revert to type. Henri Bergson, the French philosopher of evolution, explains everything by an "évolution créatrice" due to an "élan vital"; but these are just words hiding the lack of thought.

[14]Cf. Frank p. 117-8, 139-144, 229.

Let us also note that Lamarckians fall into a sort of exaggerated realism. They *hypostatize* classes of organisms, attributing to them planned operations, an urge toward a higher standard of life, a single purpose to be attained in succeeding generations. Such conceptions are chimerical. Those who hold them, should also admit panpsychism or Emerson's over-soul; for such planned operations and yearnings for a distant goal are inconceivable without consciousness. As a matter of fact, however, individuals alone live and die; classes are nothing apart from them.

The position of the evolutionists would be less absurd if with Lamarck, Dwight etc., they were to place the élan vital where it would make sense, viz. in the Maker of the classes. It is possible that God planted in some or all classes of organisms, and therefore in all individuals, a tendency to something higher.[15] But while this would make sense,[16] the facts seem dead against it.

Except for mutationists, Neo-Lamarckians and Neo-Darwinians spend most of their time in trying to find an answer to the question: How did the changes in the past come about? What were their physical causes, conditions, mechanisms? A number of theories have been put forward. But it is all love's labor lost unless the questions of fact and principle have first been settled.[17]

Fr. Marcozzi closes his article on "Le Trasformazioni di

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[15]Agar (p. 88) speaks of "directed evolution", in the sense that "definite, determined lines of evolution along which life progressed were laid down by a Lawgiver".

[16]Farges was perfectly right when he wrote in the Annales de philosophie chrétienne (1897): "If there had been evolution of species, it would constitute another marvel of order and harmony, a further addition to all the other marvels of nature which prove the necessity of creative intelligence".

[17]If one wishes for a half hour's quiet fun, let him read chapter 7 of Lamarck's *Zoological Philosophy*, where the author pretends to trace the influence of environment on the activities and habits of animals. Fr. Beraza (p. 465) promises "risum vix tenere poteris".

Trasformismo" with this observation (p. 430): "After the bankruptcy of so many theories and hypotheses to explain a fact, does not the suspicion seem justified that there never was such a fact, and that the impossibility of finding its explanation is due to a fundamental defect, viz. the pretence to explain what never happened?"

3. PEDIGREES AND SYSTEMATICS

So far we have studied the scientific theory of evolution in itself. But evolutionists go a step further. They want to persuade us that the pedigrees which they have drawn up with great labor, should now take the place of predicamental trees. Thus the author of the article on Botany in the Encyclopedia Britannica states curtly: "A perfect system should be a genealogical tree representing the story of plant life from its remote origin". G. M. Allen likewise says: "A true classification must be based on genealogy, just as our family trees are based on relationship". That this is the modern method of classifying plants, is attested by N. Taylor (p. 187): "The families", he says, "are arranged in the order that seems to reflect the development from the simpler to the most complex, and is the sequence of such families used by nearly all botanists in describing the plant families of the world".

Such a practice is the outcome of a deplorable confusion of ideas. The genealogical trees drawn up by naturalists, were they ten times as complete and correct as evolutionists make them out to be, are of little help to the systematist. At least the philosopher, if not the botanist and zoologist, is after genuine predicamental trees, because his purpose is the investigation of the nature of things. He asks *what* things are. Now descent, with or without transformation, tells us nothing about the nature of either parents or offspring—no more than a genuine family tree tells us any-

thing about the character, occupation, etc. of the ancestors there listed.

Therefore it is a pedagogical crime to propose such genealogical trees to beginners as the last word on plants and animals.

CONCLUSION

Fr. Anable, of Fordham University, while denying that evolution is an established fact, is willing to grant it the status of a "good theory" (p. 89). It may have been once, inasmuch as it offered a possible explanation of some puzzling facts of paleontology. Today things are different. L. T. More himself admits that the theory of evolution must be held on faith, not on the strength of the arguments adduced in its favor. These, as we saw, everywhere collide with facts and principles.

Personally I am convinced that biologists, in adopting the theory of evolution, have saddled themselves with a corpse, and that the sooner they get rid of it, the greater will be the true progress of their noble science. But whether the reader agrees or disagrees with this view of mine, he will not be surprised if in the next chapter we shall simply disregard the theory of evolution, since it furnishes no aid to systematics.

CHAPTER 24

Wanted: Two Porphyrian Trees

Botany and zoology are undoubtedly sciences. Now the aim of every science is a predicamental tree; for only after a genuine predicamental tree has been worked out, can science proceed *deductively*. The last question then is: Are the classifications of modern botany and zoology true predicamental trees? Do they satisfy the rigorous demands of both science and philosophy? Or do they at least furnish unimpeachable data for the construction of predicamental trees?

Many of those who have looked into the question of classification, both professionals and laymen, naturalists and philosophers, confess that all is not well, that the results obtained so far are nothing to be proud of. We shall first recount a few recent opinions on the Linnean system as a whole, and then discuss the existence and origin of genera.

1. THE LINNEAN SYSTEM

Of the Linnean system, which is still in vogue in botany, the Encycl. Brit. (s.v. Botany) says: "Although it cannot be looked upon as a scientific and natural arrangement, still it has a certain facility of application which at once recommends it. It does not of itself give the student a view of the true relations of plants, but by leading to the discovery of the name of a plant is a stepping-stone to the natural system". Let the reader note the veiled admission that the system is neither scientific nor natural nor true; its sole advantage lies in the convenient nomenclature.

J. St. Mill was much more severe (System of Logic, Bk. 4 ch. 7 n. 2): "The only purpose of thought which the Linnean classification serves, is that of causing us to re-

member, better than we should otherwise have done, the exact number of stamens and pistils of every species of plants. Now as this property is of little importance or interest, the remembering it with any particular accuracy is of no moment. And inasmuch as, by habitually thinking of plants in those groups, we are prevented from habitually thinking of them in groups which have a greater number of properties in common, the effect of such classification, when systematically adhered to, upon our habits of thought, must be regarded as *mischievous*". And a little further on he continues: "I have seen it mentioned as a great absurdity in Linnean classification, that it places (which by the way it does not) the violet by the side of the oak; it certainly dissevers natural affinities, and brings together things quite unlike as the oak and violet are".

Mill's criticism was echoed by Fr. Joyce (p. 33): "In this system", he says, "the various species of plants are arranged in genera according to the number of stamens and pistils they possess, and irrespective of any other similarity or dissimilarity than is afforded by this single characteristic. Such a distribution is rightly termed *artificial,* even though it is based on a natural characteristic. It brings together into a common genus species which are connected by the sole fact that they have the same number of stamens and pistils, but which in all else are remote from each other; and it relegates to widely divergent classes species which in the natural order are closely allied".

Observe that each of the three authors just quoted takes it for granted that we know the "natural system" of plant species, their "natural affinities", their "natural order". But do we? Is not that exactly what all naturalists are after, what they almost despair of ever knowing, and what the philosopher cannot know without the aid of naturalists? What the authors really meant, was that a different system

would emerge if plant species were looked at from *another angle*. Which is true enough. But the ultimate question is: Which is the true angle from which to systematize plant species?

Zoologists likewise acknowledge the extreme weakness of the Linnean system as applied to their special field.

Prof. Kerr holds that "the scheme used by zoologists of the day in classifying animals . . . is merely a convenient way of expressing contemporary knowledge" (p. 6). And E. W. Berry warns the budding paleontologist not "to be dismayed when he finds wide diversities of presentation in different texts based upon the same facts" (p. 4). R. L. Hyman, too, confesses (p. 128): "The details of classification are not yet agreed upon, because we know as yet little about natural relationship of animals, and it is difficult to decide whether certain differences between two animals will place them in different genera only, or whether they are great enough to separate them into different families. For this reason, the student need not be surprised to find that the various textbooks are not agreed on the details of classification". The author of the article on Zoology in the Encyclopedia Britannica disclaims anything like finality for the modern classification of animals: "The present state of classification", he writes, "must not be regarded as authoritative or final, since the rapid progress of knowledge is introducing incessant changes in our conceptions of the relations of the greater groups. The reverse error must, however, be guarded against—that of supposing one classification as good as another, for each really marks a stage of progress". Perhaps it does. But how can we speak of progress as long as we do not know the goal, which is the natural system? What guarantee have we that our modern systems approach it closer than did the older ones?

Generally speaking, botanists, more than zoologists, are

inclined to accept "practical" classifications, which permit rapid identification. The reason is that the morphology of plants is simpler and less varied than that of animals.

That lack of a philosophical background is responsible for this state of affairs, is indicated by E. Mayr (p. 4): "Systematics", he says, "is in a more difficult position than most other sciences. It seems as if all the conclusions and generalized laws derived from a study of taxonomic material were dependent to a very high degree on the nature of this material and the background of the student. The result is that—partly from the variety of material, too—we have an almost *unlimited diversity of opinion* in answer to such questions as: What is a species? How do species originate? Are the systematic categories natural? and so forth. There is *no uniform point of view* among taxonomists; in fact, in regard to many of these questions there may not even be a majority opinion. . . . This is true not only for the plant taxonomist versus the animal taxonomist, or the parasitologist versus the zoologist, but also for the opinions of the taxonomist of fresh-water organisms as compared with those of the student of terrestrial animals, or of the students of continental and insular faunas, and even of different taxonomic groups—let us say the opinions of the taxonomist of diptera and mollusca, as compared to those of the ornithologist. The situation indicates clearly that no one taxonomist can yet attempt a broad outline of the generalizations deductible from systematics that is acceptable to all his fellow taxonomists".[1]

2. EXISTENCE OF GENERA

The nature of predicamental trees on the one hand and the uncertainties of modern systematics on the other oblige us to face the more fundamental question: *Are there any*

[1]Italics mine.

genera at all? Would it be absurd to say that all plants, though broken up into thousands of natural species, yet belong to one genus? Or all animals? In other words, could one maintain, with some show of reason, that what naturalists call two kingdoms, are really two genera proxima? And since modern systems suppose a gradation of genera (lowest, intermediate, highest), we must ask a further question: Are there solid grounds for admitting such a gradation: families, orders, classes, phyla?

1. Now not only naturalists, both ancient and modern, but also the Scholastics suppose the existence of genera within our flora and fauna, that is, natural divisions below the kingdom and above the species. T. Pesch remarks briefly (Inst. Phil. nat. II n. 582) that while authors differ in their classifications, yet no one ever doubted the existence of genera. But what is the scientific basis for asserting the existence of genera? I know of no list of criteria for distinguishing genera as we have for species, and as we saw, many naturalists are willing to leave the distinction of genera to the considerate judgment of the botanist or zoologist.

Still, there seem to be three more or less plausible *criteria.*

a. One criterion, though of limited applicability, is the possibility of genuine *hybrids*. Certain natural species, both among plants and animals, can be crossed, others cannot. Would it be absurd to say that the possibility of hybridization is due to a closer natural relationship?

b. Another criterion might be similarity of specific characters and its obverse, marked gaps. At least among animals, some species are so similar in their specific characters that they seem to constitute a higher group. No one doubts that fishes, birds, snakes, cattle etc., though themselves broken up into many species, and though essentially alike in many ways, yet constitute distinct natural groups.

c. Animals might be grouped into genera by means of their *instincts*. Not so much those instincts which are common to all animals, but rather those which serve a specific or purposive activity; e.g. the instinct for guarding against rodents, for fishing, for catching insects on the wing, for aerating the soil etc.

2. It is fairly certain then that the two kingdoms of life are not only differentiated into species, but also into genera. But what shall we say of the *higher groups*: families, orders, classes, phyla and subkingdoms? Have we any assurance that there are such higher natural genera?

Professors Hyman and Yonge are sure that the phyla of both kingdoms are settled and universally accepted, and there are many others who have voiced the same opinion. One wishes it were so. But comparing the writings of botanists and zoologists, one comes to the conclusion that there is little agreement.

Furthermore, one may doubt if the divisions so far excogitated are *essential*, as they are supposed to be.

Plants, as we saw, are generally divided into flowering and flowerless. Though the division is fairly obvious and has the advantage of dichotomy, we do not see how the essence of plants is thereby affected. N. Taylor (p. 14) denies that it is a true division, calling it merely practical. Other divisions have been suggested, such as rooted and rootless, self-sterile and self-fertile etc. But who can tell whether these are essential, generic, highest? Then there are those who, dismissing subkingdoms, at once divide plants into a number of phyla.

Again, since Lamarck, the animal kingdom is divided into invertebrates and vertebrates. This division, too, has the advantage of dichotomy and seems fairly obvious—if anatomy alone is taken into account. But is that the right angle from which to survey the animal parade? Aristotle spoke

of blooded and bloodless animals. If the scholastic definition of "animal" is retained, animals might be divided according to the number of senses they possess, as was done by Lorenz Oken; for it seems certain that not all animals have all the external senses known to us, and that some have senses unknown to us.

But if our definition of species is correct, it seems that generic differences, both in plants and animals, should be based on differences in extrinsic purpose, and that the balance of nature should be made the guiding principle for the highest genera. It seems a sound instinct on the part of recent biologists that they make much of ecology and biosphere, the natural environment of each species.[2]

At the present state of our knowledge, any higher group can at most be tentative and systematic.

3. THE ORIGIN OF GENERA

In his "Species and Varieties" (p. 32-4), Hugo de Vries gives an interesting account of a controversy which divided the great naturalists of the 17th and 18th centuries. The question then debated was: Did God originally create genera or species? Prior to Linné, naturalists held out for genera. So did Linné in his earlier works; but he later changed his mind and maintained that God created species.

Rightly so. The genus, as technically opposed to species, is something essentially incomplete, a (metaphysical) part of the species; for the species consists of the genus and the specific difference. Now as we know a priori and a posteriori, nature knows nothing of halves; nature never makes parts for their own sake; it makes parts only in making the whole. Moreover nature knows only individuals, and an individual is a complete substance.

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[2]Cf. MacDougall ch. 6 and p. 871-4; E. Mayr p. 277-9; Hegner, *College Zoology* p. 5-7.

Therefore *God created genera* by creating species of plants and animals, or rather individual plants and animals with specific or complete essences. Holman and Robbins reject creation, because it "does not furnish any explanation of the close resemblances which exist between certain kinds of organisms" (p. 336). The explanation lies in God's overall plan. Supposing the species of nature to be immutable, Agassiz rightly said that "the systems of the naturalists are the Creator's thoughts transplanted into human language", that "classification, rightly understood, means simply the *creative plan of God* as expressed in organic forms" (p. 42). Cf. Boyer p. 199.

W. Hofmeister concluded from his comparative studies of plants that all plants are genetically related, because their germination, development and fructification are generically similar.[3] This argument is unsound. Generic similarity does not prove genetical relationship. No species, either of plant or animal, has a real brother or sister or cousin.

Catholic Lamarckians, who cling to a mitigated form of evolution and embody it in their distinction between natural and systematic species, really make their natural species out to be genera. They think that God in the beginning created genera (natural species), not the species of modern zoology and botany (systematic species). It is a return to Linné's earlier position.

CONCLUSION

If this is the present situation, the layman can only conclude: Modern classifications of plants and animals, meaning the relationship between the lowest, intermediate and highest genera as outlined by naturalists, are *systematic*—in our sense explained for species. E. Mayr agrees with this conclusion when he says (p. 290-1): "The genus of the sys-

[3]Cf. Locy p. 431-5.

tematist is his own artificial creation, and not a natural unit. The same is true for the higher categories above the genus (family, order, and so forth)". Like the actual species of botany and zoology, the present classifications are hypotheses, tentative groupings, to be accepted or rejected as they meet or fail to meet the rigorous demands of a sound philosophy.

And if this is so, the present *definitions* and *scientific names* are not final. For a correct definition as well as the species name are made up of the lowest genus to which a thing belongs, and the specific difference. Therefore if both the lowest genus and the specific difference are systematic, so are the definitions and species names. That the scientific names in current use are highly arbitrary, was pointed out long ago by J. St. Mill (System of Logic, Bk. 4 ch. 7 n. 5).

Nevertheless, the present systems, definitions and species names have their advantage, to which Fr. Joyce calls our attention (p. 383) : "Investigators have had recourse to these classifications when the perplexities of the natural system have been such as to baffle their efforts to arrange the classes. In such cases, they have judged an artificial system *better than chaos*. It at least enables us to assign a definite place to each member of the group in virtue of distinctive and easily recognizable marks".

For the present, our part is to practice patience and wait till God give the world another Linné. And even when he has come and has satisfactorily worked out the two Porphyrian Trees we are after, it may take a long time before his work is accorded universal recognition.

CHAPTER 25

The Human Race

Although this subject is really beyond my scope, yet its relations to the matter in hand are so close that it cannot be ignored. The very term "human species", a frequent synonym for the human race, obliges us to discuss it in an essay on natural species.

Now while any number of problems come to mind in this connection, it seems sufficient to prove first that man today is one species, a species infima, and then to extend that thesis to prehistoric man. After that, to clarify Catholic teaching on the origin of the human race, we must speak of Adam and Eve, the ancestors of the human race. Finally, as a conclusion befitting a philosopher, we shall add something about possibilities of other human species.

1. HOMO RECENS

Our first question then is this: What shall we call man today? Is the human race, such as we know it from experience and from authentic history, a natural species? Or are there several human species today, so that it would be better to call man a genus, as Linné thought and as the Latin "genus humanum" implies? Or should we perhaps go higher with some zoologists and call him a family or an order?

The common scholastic thesis is that man today is *only one species*, and that therefore all divisions of mankind are infra-species. There are several lines of argument to establish this thesis.

a. All human beings of whom we have any knowledge (and our knowledge today is comprehensive), have the *same complete essence*, and there is no essential difference

between them. No doubt, there are among us many races; language and customs vary from country to country; unequal, too, are the stages of civilization and culture which the tourist meets in his travels and the historian unearths in his records. But common sense agrees with the Declaration of Independence that all men are born equal. Equal in what? Not in weight or wealth or opportunity, but in this that all have the same human nature with the same essential and inalienable rights and duties.

Some have indeed argued that the difference between a civilized man and a savage is greater than between a savage and an animal. But this is untrue. The savage can become civilized, the animal cannot. Then, too, no animal has an idea of morality or religion, whereas anthropology assures us that even the lowest savages distinguish between right and wrong, that they believe in a supreme being etc. In other words, while the difference between the civilized man and the savage is infra-species, that between man, the savage included, and the animal is essential.[1]

b. The scholastic thesis is confirmed by an application of the *criteria of biological species,* especially of two: indefinite fertility and the life-cycle.

We know that all men are—per se—indefinitely fertile among themselves. Distinctions of race or color have no influence; the white man can mate with the African negress, the American Indian with a white woman or with a negress or with a Chinawoman; if anything, the fertility of offspring increases with difference of race.[2] On the other hand, the law of mutual sterility separates man from all other animals. There is no record of what Scholastics used to call

[1]Cf. Dezza p. 86. To prove the unity of the human species, V. Cathrein, S.J., wrote shortly before his death "Die Einheit des sittlichen Bewusstseins der Menschheit" (3 vols.) 1914.
[2]Cf. Linton p. 24.

"monsters". No offspring is known as the result of a union between a human being and any other animal, say the gorilla or the ourang, though these resemble man closely enough in their anatomical structure and physiological functions to make a positive result likely. An American professor is said to have made the experiment (through artificial insemination), but without result. The Soviet government announced in 1926 that a professor would be dispatched to Africa to repeat the experiment; that was the last heard of it. Locke indeed says (*Essay,* Bk. 3 ch. 6 s. 23): "If history lie not, women have conceived by drills" (baboons); but history may have lied. The Encyclopedia Britannica (14th ed.) has a long article on human monsters; but they are all offspring of two human beings.

Man must also be reckoned one species when the criterion of the life-cycle is applied to him. The period of gestation, of adolescence, of puberty etc. is about the same in all human beings, both as to time and kind; the "change of life" occurs at about the same age in all women etc.; not many men exceed the Scriptural age of three-score and ten. Of course, as in all biological processes, one must not expect absolute regularity. Not all men die on their seventieth birthday. I do not know if the criterion of the chromosomes has been sufficiently investigated to serve as a secure basis of induction.

c. *Anthropologists* for the most part agree with the scholastic thesis. It was held by the great 19th century scholars: Karl von Baer, Jean de Quatrefages, Sir Richard Owen etc. 20th century scholars are equally outspoken: Sir Arthur Keith, Pilgrim, Schwalbe, Wood-Jones etc. Even "Thomson's Outline", in spite of its strongly evolutionistic bias, says (p. 1093): "There are sound reasons for regarding the existing races of mankind as varieties of one species, Homo sapiens, just as the numerous breeds of pigeons are

offshoots from the ancestral stock of the rockdove". The sound reasons appealed to are the indefinite fertility of all races, their imperceptible grading into one another, the extreme improbability of another human species. Let me add three American authorities. A. L. Kroeber says (p. 34): "The existing races can all be regarded as integrating varieties of a single species". And Jordan-Heath state (p. 246): "The family of man contains but a single species, cosmopolitan and highly variable". R. Linton (p. 24) has no doubt on the subject.

d. It is therefore only of historical interest to recall some of those who formerly denied the unity of the human species. Disregarding Voltaire, who has no voice among scientists and philosophers, we may mention a certain J. J. Virey (1801), who made out whites and blacks to be two species. A. Desmoulins enumerated 11 species, each native to the place where history first discovered it. Bory de Saint-Vincent (1825) raised the number to 15. American scientists, around the middle of the last century, sided with Virey, mainly because of slavery; they also emphasized the fixity and geographical habitat of each species.[3]

e. There remains a question of nomenclature. If man be taken by himself, the criteria and definition of natural species fit him perfectly. But if we place him in the Porphyrian Tree, if we bring him in line with "animal", his status is *equivalent to a genus,* inasmuch as "non-rational animal", the other member of the same division, is at least a genus. And if we must allow that much, we may also say that man is equivalent to a family or an order or a phylum. Best of all, man is called a *superphylum,* as standing head and shoulders above all the phyla of animate nature. We

[3]Cf. Vigouroux IV p. 7-13; Lyell II p. 475-6; Beraza p. 435; Schneider p. 343-365, 420-7.

must beware of forcing our nomenclature, willy-nilly, on reality, which is richer than any of our systems.[4]

2. PREHISTORIC MAN

1. The most popular argument against the unity of the human species is today taken from prehistory, the science of human remains which date from *before written documents.* The time covered by prehistory is also called the Stone Age (old, middle, new) because man then used mostly stones for instruments, not iron or bronze. Now many discoveries, consisting of near-human skeletons or parts thereof, have been made since the middle of the 19th century. Some of these skeletons are complete enough to pronounce them *fossil men* buried for thousands of years; they resemble ours so much that few would see in them a new human species. This is admittedly true of the Grimaldi race (negroid), the Cro-Magnon race (European), the Chancelade race etc. No scientist of note has failed to see in them forerunners, perhaps partly contemporaries, of the races which at present divide mankind.[5]

Against those who would dissent from the verdict of scientists, I may quote Chesterton's witty remarks on arguing from skulls: "Talking of skulls", he writes (The Everlasting Man, App. 1), "I am also aware of the story of the Cro-Magnon skull that was much larger and finer than a modern skull. It is a very funny story; because an eminent evolutionist, awakening to a somewhat belated caution, protested against anything being inferred from one specimen. It is the duty of a solitary skull to prove that our fathers

[4]Fr. Zigliara (p. 24), who holds that man is a species infima, works around the other way and calls "animal" a species *subalterna*, which has other species above and below itself. This mode of speech is apt to lead to great confusion.

[5]Cf. Murray p. 87-96; Raymond p. 284-5; Delépine, in Revue des Questions Scientifiques, Jan. 20, 1937 p. 73-83.

were our inferiors. Any solitary skull presuming to prove that they were superior is felt to be suffering from a swelled head".

2. The *Neanderthal Man* constitutes a second group. The skeletons hitherto dug up differ from ours in some points: receding forehead, enormous brows, pronounced prognathism, powerful jaws, no chin, more and bigger teeth. The geographical distribution of the Neanderthal Man seems to have been world-wide.[6]

Many anthropologists, including some Catholics, profess to see in the Neanderthal Man a new species, subhuman and essentially different from Homo recens. Perhaps. But there are weighty arguments which tell against this hypothesis.

a. The *principle of economy,* which governs the retention or rejection of any hypothesis, forbids us to assume a multiplicity of human species as long as all known facts can be fitted in with specific unity. Because the Neanderthal Man shows some anatomical features foreign to Homo recens, scientists may be justified in declaring him a new (or rather extinct) race and in bestowing on him a new name; but from this to a new natural species is a far cry.

b. As we saw, the notion of *biological species* is extremely vague and elastic among modern naturalists. Mere anatomy or morphology, the only evidence consulted by scientists in our case, often leaves us in the lurch where an accurate distinction is to be made between species and variety.

c. The positive argument against pronouncing the Neanderthal Man a distinct species is this: The Neanderthal Man has not only left us his skeleton, but also traces of his *art, industry and religion.* His material culture may have

[6]For a list of discoveries, see R. Köppel, in Biblica 1936 p. 85-93; Bea, in Verbum Domini 1937 p. 344-7; Stenger, in Ecclesiastical Review 1939 II p. 301-310; C. J. Connolly, in The Cath. Biblical Quarterly 1943 p. 191-8; Murray p. 71-80.

been of low degree, but he was a rational being, and therefore as much a man as you or I. Chesterton's argument on this point is witty and sound: "It is little use to compare the head of a man with the head of a monkey, if it certainly never came into the head of the monkey to bury another monkey with nuts in his grave to help him towards a heavenly monkey-house".[7]

3. The third group, about which there is still dispute, is the so-called *Pekin Man* (Sinanthropus pekinensis). The 25 fragments found up to 1937 consist of human teeth, of mandibles both simian and human, and of parts of two well-preserved skulls. No other parts of the skeletons have been located so far. The fragments are not only geologically older than the skeletons of the Neanderthal Man, but seem also more primitive.

Have we then here a new human species? Weighty authorities believe so. Still, the reasons which forbid us to see a new species in the Neanderthal Man, also militate against this view. The cave in which the fragments were discovered contained cut stones, fashioned bones and traces of fire. If these are the handiwork of the Pekin Man, he undoubtedly was a rational being; if not, the only evidence to go by is a small part of his anatomy, and such an argument is hardly conclusive.

At present, it is impossible to choose. But more recently, students favor the view that the Pekin Man was an early, yet lineal ancestor of Homo recens.[8]

Father Teilhard de Chardin, S.J., has been charged with making the Pekin Man an intermediary species between ape and man.[9] An article of his in the *Etudes* (July 5, 1937 p.

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[7]Cf. Murray p. 74, 118-9; Raymond p. 281-2.

[8]Cf. Murray p. 62-71; Rüschkamp, in Stimmen der Zeit; April 1937 p. 52-5; A. Close, ib. Nov. 1940 p. 54; Johnson, in *Dublin Review* 1938 p. 322-8; Dezza p. 84.

[9]Cf. Dict. prat. s.v. Evolutionnisme col. 108-9.

5-13) does not bear out this accusation. Perhaps he has changed his mind lately; but at the most he now favors the idea that the Pekin Man, as far as we can judge from the skull, looked more like an ape than does Homo recens.[10]

4. There are still other remnants of prehistorical man: the *Heidelberg* Man, the *Piltdown* Man, the Pithecanthropus erectus or *Java* Man of Prof. Dubois, the Meganthropus of von Koenigswald, the Pithecanthropus robustus of Weidenreich etc. But it would be foolhardy, in the present state of our knowledge or rather ignorance, to say anything definite about them. Our data are far too meager, and experts disagree too widely.[11]

3. ORIGIN OF MAN

In chapter 3 we proved that God stands at the beginning of the human race, at least as far as the human soul is concerned. No dispute on this point is possible among Catholics. But some Catholics, who incline toward a mitigated form of human evolution, think that an animal may have evolved naturally until it became a fit habitation for the human soul, which was then infused by God. G. Mivart defended this theory in his book on the "Genesis of Species" (1871); so did E. Leroy in L'évolution des espèces organiques (1887) and L'évolution restreinte aux espèces organiques (1891). After them the theory was taken up by Fr. Zahm, Mgr. Bonomelli, W. M. Agar and H. J. T. Johnson. R. Linton (p. 7) thinks that that is the minimum to be granted to the theory of evolution: "That the human body

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[10]Cf. Murray p. 53-60, 108.

[11]This is also the conclusion arrived at by Fr. Poulet, O.M.I., in the Revue de l'Université d'Ottawa 1941 p. 89-91, and the gist of the second chapter of Chesterton's *Everlasting Man*, which is as worth reading now as the day it was written. Cf. H. Alimen, in *Etudes*, April 1946 p. 86-92; Marcozzi, in Civiltà Catt., Aug. 17, 1946 p. 262-271.

was evolved from some lower form of life is no longer doubted by any one who is familiar with the evidence. Structurally man has so much in common with the other mammals, especially those of the primate order, that no other theory seems tenable".

Such an origin of the human body is not intrinsically impossible, and apart from the provincial council of Cologne (1860), the magisterium of the Church has never rejected it definitely. But it is only fair to look at the other side of the picture.

In the first place, it would be difficult to square the account of Genesis with this theory, at least as far as the creation of Eve goes. Then, too, Adam and Eve would no longer be our protoparents; at least they would have had their own, though simian, parents, who would also be our ancestors. For these two reasons, all the pronouncements on the subject made hitherto by the *magisterium* of the Catholic Church are unfavorable to a mitigated evolution of man. Mivart, Leroy, Zahm and Bonomelli were asked by Rome to retract their novel theory; all but Mivart did so.[12]

Fr. Ceuppens, O.P., discusses the question in a recent number of the *Angelicum* (1947 p. 20-32). He grants that, according to Genesis 2:22-23, Eve's body was somehow taken from Adam. But he inclines to the view that, for the creation of Adam, God took the body of an animal, disposed it in a moment for the reception of a human soul and then infused into it Adam's soul. He calls this mode of Adam's origin "une certaine évolution, très modérée".

[12]Cf. Beraza p. 462-491, 495-7; Palmieri p. 248-253; de Sinéty, in Dict. apol. s.v. Transformisme col. 1844-7; idem, in Dict. prat. s.v. Evolutionnisme col. 108-113; Deneffe, in Scholastik 1939 p. 297; *Homiletic and Pastoral Review* 1939 p. 960-2; ib. 1942 p. 689-690; T. J. Motherway, in Theological Studies 1940 p. 97-116; ib. 1944 p. 198-221; Dict. de la Bible, Suppl. s.v. Génèse col. 603, 607, 608; ib. s.v. Adam et la Bible col. 93-4; Cath. Enc. s.v. Mivart; Bea, in Biblica 1944 p. 76-8.

The only question is: Can such a mode of production be called "évolution" at all?

Secondly, since no animal today shows any tendency to evolve beyond itself, to assume such a tendency for the beginning of things, would be an *ad hoc explanation*. Certainly the successive stages by which, according to Lamarck (Zoological Phil. p. 169-173), man raised himself from the ape or some other lower organism to his present high estate, betray his imagination as the only source.[13]

Thirdly, do those Catholics who flirt with the theory of mitigated evolution, realize that such a process would be equivalent to a *first-class miracle?* Such a change, being substantial, would have to be instantaneous and total. Every bone, every cell and tissue, every drop of blood, the very temperature of the body would have to change, radically and uniformly, in the twinkling of an eye. Was this possible? Not if the present laws of nature held at the time. Doctors know that a sudden change in any of the items mentioned means serious illness, if not death. God alone, by His omnipotence, could do it. The human soul, though spiritual, could not; for it has not an infinite amount of energy, and in any case its influence on the body is not that of an efficient cause.[14]

We might call it a minor miracle if a man and a woman evolved at the same time and in the same neighborhood. Once evolution is admitted, such things might happen, of course, but the chances were slim. One might also wonder why only one man and one woman were evolved that way; for, as we shall see presently, it is certain that all men are descended from one pair.

But the most popular argument against man's evolution

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[13] Cf. Murray p. 119-131; Dwight p. 119-131.

[14] Fr. Beraza (p. 488) proves that not even an angel has the power of producing such a change.

is still valid: No animal ancestor of man and no common ancestor of man and animal has yet been unearthed. The missing link is still missing. Fr. Johnson, the latest to uphold the evolution of man's body, is honest enough to admit that though "the human form has been carried very far back in the direction of the ape, no actual meeting-point between the two is as yet known. No hominid has been found which was human in bodily organization, but less than human in intelligence".[15] W. M. Agar, too, has to admit (p. 93) that "the poverty of the fossil record makes this (tracing man's ancestry) extremely difficult, and the careful, conscientious student is forced to acknowledge that we do not know much about man before the Paleolithic or Old Stone Age".

Nor can we subscribe to Sir Arthur Keith's statement (p. iv): "No teacher can give a reasonable explanation of the human body to his students unless he accepts the historical background which Darwin has supplied for man's past". Scholastic philosophy has a quite reasonable explanation without falling back on Darwin. It is that the vegetative and sensitive life of man resembles that of animals, more particularly of the primates; in fact, this is all the "reasonable explanation" that the teacher of anatomy, surgery, medicine can suppose. How this similarity came about, whether by descent or by common design, is immaterial to his explanation. He may leave that to history or philosophy.

All this, however, leaves open the further question: Of what nature was the *matter* which God took to form Adam's body? And how precisely are we to imagine the formation of Eve from Adam's side? Modern Catholic Scripture scholars, who carefully weigh the pros and cons, are very reserved when they discuss the pertinent texts from Genesis.

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[15]Cf. *Dublin Review* 1943 p. 163-8.

St. Paul seems to suppose clearly enough that the first woman came "from" the first man (1 Cor. 11:8, 12; Eph. 5:28-31).[16]

Pope Pius XII laid down the Catholic position in his address to the Pontifical Academy: "All the research work undertaken by paleontology, biology and morphology to shed light on the origin of man, has not yet led to anything clear and certain. We must therefore leave it to the future whether science, illuminated and guided by revelation, will arrive at a safe and conclusive answer to such an important problem" (AAS 1941 p. 506).

4. OUR PROTOPARENTS

1. Adam and Eve, whose creation is narrated in Genesis, are the protoparents from whom *all men are descended*. Knowledge of this fact might have reached us through profane history; for all we know, Moses, the author of Genesis, may have heard it through purely human tradition. But all our arguments are, as a matter of fact, dogmatic. Catholic theologians hold the unity of the origin of all men first because it is explicitly asserted by the author of Genesis, who, being inspired by the Holy Ghost, could not err; secondly, because it is taught explicitly by St. Paul (Rom. 5:19; 1 Cor. 15:22; cf. Acts 17:26), who was equally inspired; thirdly, because it is implied in the two Catholic dogmas of the universality of original sin and of redemption.[17]

Let us add that Catholic dogma speaks *only* of unity of origin, precisely because that alone is guaranteed by the sources of revelation. Evolutionists might admit unity of origin and deny unity of species. In their theory, the descendants of one and the same pair may, after a number of

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[16]Cf. Dict. de la Bible, Suppl. s.v. Génèse col. 607, 608; E. F. Siegman, in the *Catholic Biblical Quarterly* 1943 p. 326-7.

[17]Cf. Denzinger n. 130, 175, 789, 2123; Dict. de la Bible, Suppl. s.v. Génèse col. 603-4.

generations, split into different species. Catholic dogma is silent on this point. Just as the concept of biological species is to be determined by scientists and philosophers, so also the question of the unity of human species. The Biblical Commission (Denzinger n. 2123) insists on "generis humani unitas", not on the unity of species.[18] But as we saw, the unity of the human species is guaranteed by experience and authentic history. Also, in view of the first criterion of biological species, unity of origin would be less easy to defend on philosophical grounds if more than one human species were admitted with evolutionists.

2. Of course, neither scientists nor philosophers need suppose Catholic dogma. But they should also be slow in contradicting it. After all, no Catholic dogma, strictly so called, has yet been proved wrong. The unity of the origin of the human race in particular does not rest on purely dogmatic grounds.

It is true, paleontologists, until recently, favored *polygenism*, which might or might not imply difference of species. They thought it unlikely that Homo recens, Homo neanderthalensis, Homo pekinensis etc. should all have had the same original parents. Races or species, they differed so much in their characteristics that unity of origin seemed excluded. This argument was based on the criterion of the marked gap. But the characteristic defect of this criterion proved its undoing. What some cool-headed paleontologists

[18] When Catholic theologians, in the treatise De Deo creante, prove the unity of the human species, their thesis is independent of the scientific and philosophical concept of species. They are satisfied with the common sense notion that all those beings which are descended from the same pair, belong to the same species. But their thesis would stand with Fr. Wasmann's distinction between natural and systematic species; for Fr. Wasmann, while admitting that one natural species may branch out into several systematic species, yet holds that the systematic species are physically descended from the same natural species.

had foreseen, came to pass. Intermediary forms came to light, and now scholars of international fame maintain the unity of origin on scientific grounds.[19]

One who believes in the Bible, might find a difficulty in Gen. 6:4, where we read of *giants* living in early times, between whom and us there would be a marked gap; he might also be struck by the early patriarchs living up to and beyond *900 years,* whose rhythm of life would certainly differentiate them from us. But the exegesis of the pertinent passages is too doubtful to furnish an argument one way or another.

Some have urged *racial differences* against the unity of human origin. But these are now recognized as superficial, and the anatomical differences by which races are generally marked off, cannot constitute a solid argument, since similar differences are found within all races. More pronounced perhaps are intellectual differences; yet no race is so low as to be unamenable to education or to moral and religious instruction.[20]

Another objection is based on the *diversity of human languages.* If all men were descended from a single pair, then, it is argued, all human languages should be derived from one original language. Now no positive proof is yet forthcoming that this is so. Still, the actual diversity of languages may have other causes. Some Catholic theologians incline to the view that the confusion of language narrated in Genesis may have had the effect of rendering the human languages irreducible to one. Anyhow, experts do not despair that the original unity of all languages may yet be proved.[21]

[19]Cf. Périer, in Revue apologétique 1937 p. 277-282; L. Baur, in LThK s.v. Abstammung; de Lapparent, in Initiation biblique p. 389-390.

[20]Cf. Lyell II p. 475-6.

[21]Cf. Beraza p. 458-9; Chr. Pesch III n. 159; L. Baur, in LThK s.v. Abstammung.

3. We may here mention some older opinions which *denied* the unity of origin.

One famous theory is that of the *Preadamites,* a human race which is supposed to have existed prior to Adam and Eve, but which perished before their creation or at least in the flood. Origen is said to have favored the idea; Julian the Apostate certainly held it. Recently, E. C. Messenger thought it possible that Adam's body may have originated from a Preadamite body.[22]

Suffice it to say that the theory is purely imaginary; its patrons have not advanced a single argument that would make it probable.[23]

Less well known is the singular opinion of *Isaac de la Peyrère,* a Calvinist theologian of the 17th century. He assumed that only the Jews were descended from Adam and Eve, the Gentiles having Preadamites for their ancestors. In his theory, Adamites and Preadamites would still exist together in their descendants. Peyrère deduced his theory from St. Paul's Epistle to the Romans (5:12-4), but to defend it he had to deny the inspiration of the Pentateuch and the universality of original sin. He abandoned it on becoming Catholic.[24]

To complete the record, let us finally mention the dispute about the *antipodes.* Their existence was asserted by ancient philosophers (Pythagoras, Plato) and geographers (Eratosthenes); it was denied by others (Virgil, Lucian, the Epicureans); St. Augustine judged it contrary to experience and revelation: "nimis absurdum", "nulla ratione credendum". At the time of St. Boniface, a certain Virgil in Bavaria seems to have held them a distinct species, not descend-

[22]Cf. *Theological Studies* 1944 p. 199.
[23]Cf. Poulet, in Revue de l'Université d'Ottawa 1941 p. 93-7.
[24]Cf. Beraza p. 438-450; Vigouroux II p. 468; IV p. 5-23.

ed from Adam and Eve; Pope Zacharias rejected this opinion as contrary to the unity of the human race.[25]

4. But we must specify a little more. Both Catholic dogma and science at its best uphold the unity of human origin. But do they mean exactly the same thing? No. Catholic dogma asserts that all men are actually descended from one original pair, called Adam and Eve in Genesis. All that science can say or prove is that all men may have descended from one pair; science cannot exclude the possibility that in the beginning more than one pair may have been created. The reason for this is that, apart from historical testimony like that of Genesis, we are obliged to argue from effect to cause, and such an argument will never restrict us to one original pair. As science has no means of deciding how many individuals or pairs were created at the beginning of each animal species, so in our case.

Fr. Monaco (p. 253) proves unity of origin by the following argument: As God does not fail in necessaries, so He does not indulge in superfluities. Now one pair was necessary, but also sufficient. Therefore we can say a priori that God created only one pair, and that He willed all men to descend from them. But it is difficult for our finite minds to decide what Infinite Wisdom may judge necessary or superfluous. Even in human affairs there is a wide middle ground between what is strictly necessary and what is strictly superfluous.

5. Revelation and Catholic dogma are, however, silent on the *type* of men Adam and Eve were. Did they resemble the modern European? Or were they like the negroes, as some have guessed? Or like the Chinese, generally regarded as the oldest human race? Or like the pygmies of Central Africa, whom Fr. Schebesta considers "the most ancient of the existing races of mankind"?

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[25]Cf. Beraza p. 461-2; Cath. Enc. s.v. Antipodes; Histoire de l'Eglise V p. 541.

Evolutionists, of course, are sure that early man looked very much like an ape, and they have succeeded in persuading the curators of our museums to parade ape-like monsters as our ancestors. But this hypothesis may be dismissed as a corollary of the theory of evolution, which certainly does not apply to man, neither for his soul nor for his body.

Two Catholic writers have recently argued in favor of the *Pekin Man.* Fr. Rüschkamp reasons thus: Seeing that the Pekin Man is the earliest specimen of mankind of whom we have record, we may believe that Adam and Eve resembled him in their external features more than the Neanderthal Man or any of the post-Neanderthal races. Besides, the Pekin Man could not have been far removed from our first parents; for he seems to have lived at the beginning of the ice age, and no trace of man has yet been found in the tertiary period. H. T. Johnson (in *Dublin Review* 1938 p. 329) arrived at the same conclusion: "The Adam depicted in the Book of Genesis", he says, "is a being from the point of material culture not unlike the Pekin Man, a creature able to make use of fire, but without agriculture, domestic animals or the use of metals. Scripture nowhere suggests that Adam in physical appearance resembled the most advanced races of modern man".[26]

Shall we confess with du Bois-Reymond: Ignoramus et ignorabimus?

6. Of more immediate interest, as far as the subject of this essay is concerned, is what Catholic theologians teach about *Adam's knowledge* of natural history. For, in Genesis (2:19-20) we read: "And the Lord God having formed out of the ground all the beasts of the earth and all the fowls of the air, brought them to Adam to see what he would call them; for whatever Adam called any living creature,

[26]Cf. Murray p. 345-6.

the same is its name. And Adam called all the beasts by their names, and all the fowls of the air and all the cattle of the field".

That Adam had infused knowledge of these and other things, seems clearly asserted in Genesis and is held by all Catholics. But our question is: What was the *extent* and *depth* of this knowledge as far as natural history goes? Did he know all animals, at least all land animals and birds? Genesis says nothing about his naming fishes, nor yet trees and plants. And when he is said to have called all animals by their names, does that mean their scientific names? Does it mean that if he had handed on that knowledge of his, there would be no problem of animal species for us, since their names expressed their complete essences? And as a corollary, does it mean that Adam could make no progress in his knowledge of zoology?

Strange to say, neither Heinisch nor Ceuppens discuss these questions in their commentaries on Genesis. But many of the older Scholastics would have said yes to all of them.[27] Catholic theologians today are more reserved. Chr. Pesch (III n. 211-2) thinks it would be unreasonable to suppose that Adam knew of microbes, infusoria etc., whose existence only became known through the microscope, a modern invention. He limits Adam's infused knowledge to those things which were *necessary in paradise;* for Adam was originally destined by God to work in paradise only and to instruct his children in that.[28]

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[27]Cf. St. Thomas, Summa theol. I qu. 94 a. 3; Suarez, De opere sex dierum III cap. 9 n. 2-4.

[28]Cf. Dict. de la Bible, Suppl. s.v. Génèse col. 604; ib. s.v. Adam et la Bible col. 98; Boyer p. 314-6; A M. Lépicier, Tractatus de prima hominis formatione (Paris 1909) p. 164.

4. POSSIBILITIES

Although mankind actually constitutes only one biological species, yet a curious reader may ask: Well, *could* there not be another human species? And if so, what would it be like? What kind of beings would they be—truly rational like ourselves, yet essentially different from us?

Let us see. There seem to be two possibilities.

1. Man consists of soul and body. Now if we merely consider the *human body,* man resembles most what zoologists call primates; but why could there not be other rational animals rather resembling birds or fishes or butterflies? Man would then be a biological genus. Man, such as we know him, would constitute one species and would be defined as a rational primate, while other species would be rational birds, rational fishes, and so on. Why not?

In his book "Ice Ages", Prof. A. P. Coleman, of the University of Toronto, plays with the idea that but for the rude interruption of the Permian ice age, "possibly gigantic insects with large brains might have led the world intellectually in later times instead of vertebrates". Prof. Coleman is an evolutionist of the most thoroughgoing kind, to whom succession means descent and evolution toward something higher. Be that as it may; I introduce his rational insects here merely to illustrate what another human species might conceivably be.

J. Maritain indeed is sure that such creatures are impossible, "because no diversity in the material order can create a difference of essence among those animals of whom the substantial form is the nous" (in Foreword to Adler's "Problem of Species"). But Fr. Fröbes says in his "Logic" (p. 86): "Et vere probabile non est, Deum non etiam animalia rationalia creare potuisse, aut forte aliis temporibus aut in aliis partibus mundi creasse, quae in natura sua cor-

porea aeque inter se differrent ac species brutorum valde diversae".

Yet while such a multiplication of human species does not appear impossible to us, it may well be that another human species would be a living contradiction. Swift invented the Houyhnhnms, rational horses, and Greek mythology is full of strange creatures: centauri, cyclops, dryads, sirens, nymphs, and so on. The poets, their creators, attributed to them animal bodies and at least sóme sort of rationality. But who can understand them? Perhaps they are simply impossible, and therefore, though imaginable, yet really inconceivable. We have no data one way or another.

2. But there is another possibility. Since man consists of soul and body, we may suppose that the Creator could make two or more *kinds of human souls* without modifying the essential structure of the body, that is, without changing its fundamental resemblance to the primates.

Father J. Gredt, O.S.B., who became interested in this question during the last years of his life, denied such a possibility. He argued thus: The process of *intellectual cognition* dependent on senses cannot be other than we find it in ourselves; it must necessarily pass from abstract concept to judgment to reasoning; therefore intellectual cognition cannot be further diversified. Even if there were rational beings with more or fewer senses than ourselves, they would not constitute another human species.[29]

Fr. Gredt leans rather heavily on some of those principles of "Thomistic" metaphysics which are less evident and for that reason not accepted by all Scholastics. But apart from this, one might reply that a parallel argument could be formulated for angelic cognition and would not hold. For one might say that intellectual cognition independent of the

[29] Gredt's argument is outlined by M. Thiel, in Divus Thomas 1942 p. 10-5.

senses must necessarily be of the same kind, and that therefore all angels must belong to one species. Yet many Scholastics, among them St. Thomas, teach that angels differ essentially among themselves, and that they are not only diversified into species, but into hierarchies; some even go so far as to intimate that each angel is a species, being essentially different from every other angel.[30] How then can we declare a priori that another kind of human soul, essentially different from ours, is an impossibility? Do we know enough about either human or angelic cognition to be so positive?

Far from us indeed to set bounds to God's omnipotence. But one thing is certain: Man, as we know him from authentic sources, is one species. And we are, in this essay, concerned with reality, not with the fancies of poets nor with abstract possibilities.

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[30] Cf. Suarez, De angelorum natura, lib. 1, cap. 12-5; Beraza p. 210-4.

Where St. Thomas discusses beatific vision (Summa theol. I qu. 12 a. 8), he proposes to himself the following objection. Man naturally desires to know *all* things; yet even beatific vision will not satisfy this desire. How then can man be happy in heaven, seeing that a natural desire remains unfulfilled?

His answer distinguishes: "Man naturally desires to know all those things which pertain to the perfection of the intellect; and those are the *species and genera* of things (with their reasons); whoever sees the divine essence, sees them in God. But to know other things (particular objects, thoughts, facts) does not pertain to the perfection of the created intellect. Therefore there is no natural desire of such knowledge".[1]

St. Thomas' answer may not please everyone today. Even Suarez did not accept it (De divina substantia, lib. 2 cap. 28). But it shows how high he and the medieval Scholastics rated the knowledge of species and genera. They made it part of man's beatitude in heaven. It also shows how far the "modern mind" is removed from the scholastic; nowadays we "stick to facts"; universal statements are by their nature suspect and so neglected.

Truth to tell, we must not exaggerate the importance of either the universal or the singular. Each has its own distinctive value, and the human mind is satisfied with the knowledge of neither if the other is excluded. While the goal is to know the universal and through it the singular, yet we cannot know the universal except we begin with the singular. This may sound like a vicious circle, but it is not. The Scholastics resolved it by their "intellectus agens"

[1]Cf. ib. I qu. 85 ad 3; Summa contra Gent. I 84, 7; Quaestio de Anima 18.

and the intellect's return to the phantasm, and no better solution has yet been offered.

In the last analysis, we cannot but praise the louder the wisdom of the Creator the more we study His plan of creation. With what rapture Linné exclaims in his Systema Naturae: "O Jehova, quam ampla sunt tua Opera. Quam sapienter Ea fecisti. Quam plena est terra possessione tua". And again: "Magnus est Deus noster et magna est potentia Eius et potentiae Eius non est numerus. Docuisti me Deus a Juventute mea, et usque nunc pronunciabo Mirabilia Tua".

I can do no better than echo Linné's hymn of praise and close this essay with the inspired words of the psalmist: "Domine, Dominus noster, quam admirabile est nomen tuum in universa terra".

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